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The Cape Cod Canal

No engineering undertaking in the United States has a longer history than the Cape Cod Canal. Few indeed have been more thoroughly investigated, surveyed and reported upon—and so invariably recommended as feasible—than this eight-mile waterway through the sand hills of the Massachusetts coast. Perhaps no other artificial waterway in America of equal magnitude could bring about greater saving in lives and property which at present are paid in annual toll by wrecks on the Cape Cod coast.

Cape Cod is a hook-shaped peninsula projecting some 30 miles to the east of the mainland of Massachusetts and partly inclosing an arm of the ocean variously known as Massachusetts Bay, Cape Cod Bay, or, in the immediate vicinity of the canal entrance, as Barnstable Bay. This bay is protected by the cape on the south and east, but open to the north, and as most of the winter storms blow from the northeast, sailing vessels and tows of barges caught by a gale west and north of the point of the cape are almost certain to be driven upon the low sandy shore within the arm of the hook. Outside the cape are dangerous shoals, which, combined with rough and foggy weather, often make this part of the coast extremely hazardous during the fall and winter. Barge tows are often compelled to wait several days before attempting to round the cape.

The total tonnage of vessels rounding Cape Cod annually is estimated to be 25,000,000, and the passengers carried 500,000. The canal will shorten the distance between Boston and New York by 66 miles. The actual time saved coasting vessels will be in much greater proportion during rough weather by avoiding the now necessary delays. The saving in insurance for vessels using the canal will also be considerable.

On the south side of the peninsula, at the base of the hook, is Buzzards Bay, which is almost land locked and forms an expansive and magnificent harbor. From Buzzards Bay the passage into Long Island Sound is easy and can be made in all kinds of weather without danger. A canal through the base of the hooked peninsula, from Barnstable to Buzzards Bay, will therefore make possible an inland waterway from Boston, Mass., to New York City and points south, except for the short but exposed stretch of open water between Boston and the Barnstable Bay entrance of the canal.

The country through which the canal prism passes, from the low salt marshes west of the town of Sandwich to the Scussett River, across a low dividing ridge, and down the valley of the Monumet River to deep water in Buzzards Bay, is a most remarkable physical formation. It has every appearance that nature intended a waterway at this place, or that there had some time existed a channel there.

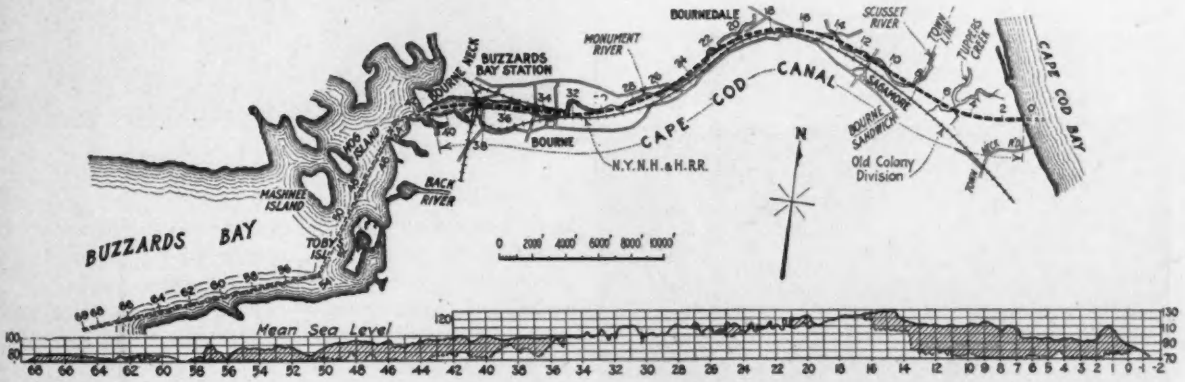

FIG. 1. PLAN AND PROFILE OF THE CAPE COD CANAL. PROFILE SHOWS PROGRESS OF EXCAVATION TO NOV. 1, 1912

The valley of the Monumet River is low and broad and is of an alluvial formation, consisting of sand and gravel mixed with large and small boulders. The direction of the valley is nearly northeast and southwest. The tide flows up the Monumet River for three miles and the headwaters of this stream nearly overlap the headwaters of the Scussett River, which flows into Barnstable Bay.

The ridge dividing the headwaters of the two rivers is only three-quarters of a mile wide and but 29 ft. above mean sea level. The width of the valley is about 650 ft. at its narrowest point and expands gradually toward each end. The hills rise on either side of the valley in gradual slopes to heights of from 60 to 180 ft.

Except for the narrow dividing ridge, the canal prism excavation required the removal of but little material except between the high-water level and the bottom of the

canal. There is no physical obstacle to a canal as deep as may be desired, and the width may be made at least 600 ft. The material excavated is chiefly sand, with underlying strata of hardpan in some places. Through the salt marshes at the eastern end, the material is of a peaty nature but not difficult to dredge. The boulders are too few to offer any serious trouble.

The tides in Buzzards Bay have a mean rise and fall of 4.11 ft., and in Barnstable Bay of 9.17 ft. The times of high and low water in the two bays are different; the high water is nearly 3½ hours, and the low water 4½ hours, earlier in Buzzards Bay than in Barnstable Bay. The durations of rise and fall in Barnstable Bay are nearly equal, but differ in Buzzards Bay by about 1½ hours, the rise being rapid and the fall delayed.

FIG. 2. VIEW OF THE BUZZARDS BAY ENTRANCE TO THE CAPE COD CANAL

FIG. 4. LOOKING EAST THROUGH CAPE COD CANAL CUT NEAR SAGAMORE

Low water occurs in Buzzards Bay soon after high water in Barnstable Bay, while high water in the former occurs after the tide has risen considerably in Barnstable Bay. The maximum difference in sea level in the two bays may be about 8 ft. Hence all the early plans for the canal contemplated the use of locks.

The slope of the surface of the water through the canal for the maximum difference in sea level in the two bays corresponds to a velocity of currrent of 6 ft. per sec., or 4 mi. per hr. Curves in the canal alignment will reduce this velocity and the flow will, of course, be maximum for very short periods only. For the canal of the cross-section now building there will be a current due to mean tide differences of about 2½ miles per hour, which will flow northerly when it is low tide in Barnstable Bay, and southerly when it is high tide there. The maximum current is little greater than that of the Mississippi River or of the Ganges Canal in India, and it is not anticipated that any seriously destructive effect on the canal banks will result; at least no more erosive action is expected than from the ordinary wash of steamers' screws.

The length of the canal from shore line to shore line is eight miles; from the 30 ft. depth contour in Barnstable Bay to the same depth in Buzzards Bay is 13 miles. The minimum width of the bottom is to be 100 ft.; the Barnstable Bay approach channel will be 300 ft. wide, and the Buzzards Bay approach channel 250 ft. wide. The canal will have a depth of mean low water of 25 ft. The banks through the sand will have a slope of 1 on 3, and

FIG. 3. CAPE COD CANAL CUT AT DEEPEST PLACE

in soft or exposed places will be rip-rapped from 6 ft. vertically below low water to 6 ft. above high water. It was the original intention to place rip-rap on practically all the banks, but this has been deemed unnecessary.

The only engineering work aside from the excavation of the channel has been the construction of a 3000-ft. breakwater to protect the eastern terminus of the canal and the relocation and rebuilding of several miles of the Old Colony R. R. (now a part of the New York, New Haven & Hartford R. R. system) and several public highways. The railway work included the construction of a 160-ft. span bascule lift drawbridge and the road construction of two highway drawbridges of similar type. The foundations of all the bridges are constructed on the basis that the canal may have an ultimate depth of 34 ft.

Fig. 1 shows a plan and profile of the canal. The profile shows the progress of excavation to Nov. 1, 1912. The accompanying views show the state of the work at the beginning of the present fall and winter season. The work is continued throughout the winter months with a somewhat reduced force. Dredging in Barnstable Bay is continuous throughout the winter months, but Buzzards Bay often freezes over in very cold weather.

It is readily seen that the construction of the Cape Cod Canal involves no engineering problems not met with in the excavation of any ditch. It is not an enterprise of great magnitude, as the whole amount of material re-

moved will not exceed 17,000,000 cu.yd.; yet it possesses a great deal of interest, due in no small measure to the viscissitudes of fortune the project of constructing the canal has passed through in the 300 years of its history. The officials of the present company have prepared a brief synopsis of the progress made in this time, which, however, is by no means complete. It is as follows:

CHRONOLOGY OF THE CAPE COD CANAL

1602 Cape Cod discovered by Bartholomew Gosnold.
1605 De Monts, a Frenchman, cruised around Cape called it "Malebarre."
1620 Arrival of Pilgrims.
1623 Miles Standish inspecting coast south of Plymouth.
1627 Standish trading at Manomet with Dutch from New Amsterdam. Boats within three miles of each other. Small canal talked of.
1676 Samuel Sewell examined canal route for "a passage from the South sea to the north."
1697 General Court Massachusetts appoints a committee to view the place for a passage from Barnstable Bay to Manomet Bay.
1717 Captain Cyprian Southack describes a free water connection across the Cape Colony of Massachusetts. Individual examinations for shallow canal until
1776 General Washington ordered Thomas Machin to survey the route which would "give greater security to navigation and against the enemy." Also James Bowdoin and Wm. Sever appointed a committee to investigate subject.
1780 Gen. Henry Knox using influence to have government build canal.
1791 John Hills and James Winthrop make survey.
1798 James Sullivan and others petition legislature to build.
1803 Committee appointed by legislature to interest people in project.
1808 Gallatin, Secretary of Treasury, advocated it as "useful in time of war."
1812 Isthmus used by small boats to avoid capture by enemy.
1818 Israel Thorndike and Thomas H. Perkins employed Laommi Baldwin to survey route. 5,000 ships rounding cape.
U. S. Senate made survey for a canal sufficient to admit vessels of war.
1824 U. S. under resolution of Senator Lloyd ordered Major Perault to make survey. Various army officers reported route practicable.
1825 Further surveys made under government orders until 1827.
1828 Government Board reports on canal 36 ft. wide, 8 ft. deep, to cost $669,522.
1844 Lieut. G. S. Blake, U.S.N. Survey.
1860 Renewed interest by Massachusetts and government. Surveys by Brig. Gen. J. G. Totten, Prof. A. D. Bache, Supt. Coast and Geodetic Survey, Comdr. C. H. Davis U.S.N. and Lieut. J. Wilkinson, U.S.N. Report on 18-ft. canal to cost $10,000,000.
1870 Charter to Cape Cod Ship Canal Co., to Alpheus A. Hardy and others. Maj. Gen. J. G. Foster, U.S.A., examining route under orders. Reports on practicability of 23-ft. canal without locks.
1870 Senator Chandler introduces Bill in Congress to pay for breakwater.
1880 Charter granted to Cape Cod Canal Co. Henry M. Whitney and others interested. Some work done but project abandoned.
1882 Gen. G. K. Warren, U.S.A. Engrs., reports to government on canal and cost of approaches.
1883 Cape Cod Ship Canal Co., authorized, William Seward, Samuel Fessenden and others interested. Funds advanced by Quincy A. Shaw. Company made contract with F. A. Lockwood. Excavated over one million yards and failed.
1890 Property assigned to Colonel Thomas L. Livermore by F. A. Lockwood.
1891 Charter granted to E. L. Corthell and others in the name of Massachusetts Maritime Canal Co. This charter lapsed.
1898 De Witt C. Flanagan of New York became interested.
1899 June 1, Charter to the Boston, Cape Cod and New York Canal Co. under which and its amendments present company is acting.
During the three successive years Mr. Flanagan, Gen. C. C. Dodge and associates advocated canal. Reports from the Engineers A. L. Rives and E. L. Corthell.
1904 August Belmont and others became interested.
1906 Voluminous report under instructions from William Barclay Parsons, C.E., from C. S. Sims to F. D. Underwood.
1907 May 8, Approval by Joint Board of Railroad and Harbor and Land Commissioners of the present location of canal.
1909 June 22, work begun officially by Mr. Belmont at Bournedale.

From the synopsis given it can be seen that the present company began work after nearly forty years of successive failures of private companies to build a canal. After the elaborate state and government surveys of 1860, which contemplated a canal 20 ft. deep with locks at both ends, the scheme seems to have been dropped until private enterprise took it up, although a census of wrecks on Cape Cod was made from 1843 to 1869, by which it was found 1444 wrecks had occurred, causing an average annual loss of $500,000.

In 1870, the Massachusetts legislature granted an exclusive charter to a private company and this project was kept alive with varying fortunes until its charter expired in 1878. Clemens Herschel was chief engineer of this company, and the canal contemplated was 7.3 miles long, 18 ft. deep at low water and was to have been operated without locks. The estimated cost was $2,500,000.

In 1880 a charter was granted to the Cape Cod Canal Co., and again elaborate surveys were made and announcements issued that the work of construction was about to be pushed with great vigor. Of this enterprise George H. Titcomb was chief engineer. Work was actually begun in September, 1880, with considerable gusto, but by Oct. 20, we read that the Italian laborers were unpaid, with but two days provisions on hand, and were on the verge of riot.

The first really earnest endeavor to dig the canal was in 1883. At this time there was considerable competition for charters, one proposal being made by French capitalists. In July of that year the Cape Cod Ship Canal Co. came into existence and deposited the sum of $200,000 with the State of Massachusetts as a guarantee of good faith. George H. Titcomb was chief engineer and the contractor was A. D. Fox & Co., of Montreal, Que.

Work was begun auspiciously in October, 1883. On the 11th of the month a grand reception was tendered the chief engineer at Sandwich, in which 500 people and two brass bands participated. The state had specified that $25,000 must be expended in the first four months on construction, and the company appears to have endeavored to fulfill this condition. During the latter part of the month a force of 400 men was employed and work was continued at night by the use of electric lights.

In December, 1883, the contractor became involved in a controversy with the company and applied for a charter to construct the canal on his own responsibility. However, it was currently reported that he was acting in the interests of the Old Colony R.R. Co. to put an end to the project, and a charter was refused. The contract was then turned over to F. A. Lockwood, and C. M. Thompson became chief engineer. Work was carried on continuously for several years, although with constantly diminishing industry. Most of this excavation was by dredging and amounted in all to about 1,000,000 cu.yd.

A note in our columns in 1887 stated: "It is reported that one mile of the Cape Cod Canal is finished. Considering that this canal was originally chartered in 1670—more than two hundred years ago—progress has been very gratifying, but the Panama Canal may yet be the first to be open for traffic."

The work under Lockwood dragged along until 1890, when the construction company was assigned by Lockwood to Thomas L. Livermore, manager of the famous Calumet & Hecla mines. In June, 1890, all work was abandoned. A year later the Boston, Cape Cod & New York Canal Co., was incorporated with a capital of $5,000,000. The state refused a charter until the company should deposit $500,000 with the state treasury. Of this sum $100,000 was to be forfeited for non-performance of the work; installments of $100,000 each were to be returned to the company at certain stages of progress. The company failed to deposit the necessary fund and the scheme dropped back into the hands of the old company.

During the ten years which intervened between this attempt to obtain a charter and the final granting of a charter to the Boston, Cape Cod & New York Canal Co., in 1899, various other schemes were launched under the names of the Bass River Canal Co., the Old Colony & Interior Construction Co., and the Massachusetts Maritime Canal Co., all of which got no further than more surveys, reports and plans. The old scheme to construct the canal farther east on the cape, between Yarmouth and Dennis was also revived by a proposed Massachusetts

Ship Canal Co. A bill was introduced in the Massachusetts legislature in 1897 which proposed to construct the canal by convict labor.

The Boston, Cape Cod and New York Canal Co. was chartered in 1899 with a capital stock of $6,000,000. The application of the company to issue its $6,000,000 of stock and a $6,000,000 bond issue before the construction of the canal was begun was denied by the Massachusetts River and Harbor Commissioners. The company did obtain permission to issue bonds for $140,000 to cover preliminary expenses of engineering upon the deposit of $200,000 with the state treasury, and once more elaborate surveys, plans and profiles were made. It is under the charter of this company and amendments made later that the present company, headed by August Belmont, of New York City, has undertaken the work.

Work was officially begun by Mr. Belmont on June 22, 1909, and has progressed without interruption to date. The original agreement was to have the canal completed in the fall of 1912, but an extension of time has been granted, within which at the present rate of progress the work will be done.

On Nov. 1, 1912, the breakwater near Sandwich, which will contain 350,000 tons of stone, was 88% completed. Of the 16,329,000 cu.yd. of excavation required, one-half, or 8,179,850 cu.yd., has been removed. Divided into divisions, the Buzzards Bay channel was 73% completed, the canal prism 43% completed and the Barnstable Bay channel was 33% completed. Of the 200,000 tons of riprap necessary for lining the slopes, 23% was in place. There were at this time four steam-shovels and a 16-in. suction dredge at work inland; two dipper dredges in Barnstable Bay and three dipper dredges in Buzzards Bay, all in service.

The construction work is done through the Cape Cod Construction Co., of which William Barclay Parsons, of New York, is Chief Engineer, Eugene Klapp, of New York, Deputy Chief Engineer, and Charles T. Waring is Resident Engineer, at Sandwich, Mass. The Resident Engineer until March, 1912, was H. W. Durham, who resigned to become Chief Engineer of the Bureau of Highways, Borough of Manhattan, New York City.

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The Repeal of the Tarsney Law, at the last session of Congress, was commented on by Walter Cook, President of the American Institute of Architects, in his address at the recent annual convention of the Institute as follows:

The Tarsney Act, authorizing the designing of our government buildings by architects, has been repealed; and for the moment these great monuments of our country have been handed over to an official factory, to be turned out by the yard; for whatever the talent and the ability of the Supervising Architect of the Treasury, this is what must of necessity result.

Nothing of this sort has ever happened in any civilized country, so far as I know, unless our own unhappy experiment of years ago may be considered an exception. It is quite unnecessary for me to speak of the so-called arguments which were employed in urging this repeal—the plea of an economy which has, we believe, been shown not to exist, and certain others which displayed an almost ludicrous ignorance of the whole subject. But if any of our special guests of this year—sculptors, painters or authors—are unacquainted with them, we hope they will, without delay, read certain of the official documents which have been published. And they will certainly appreciate the logical sequence of this repeal—the establishment shortly of a special department of the government for the manufacture of all sculpture and decorative paintings, followed rapidly by still another, whose duty shall be to turn out all odes, sonnets or lyric verse which may be needed to celebrate the achievements of our enlightened Republic.

However, we are hopeful and optimistic; we have faith in the sober second thought of our representatives in Congress; and we look forward with confidence to legislation in the near future, which will not simply re-enact the Tarsney Act—for it had its imperfections—but will give us something even better for our country and its art.

County and Township Organization of Highway Work*

By A. N. Johnson†

Preliminary Assumptions—The mileage of roads cared for is assumed to be from 75 to 100, of which approximately 75% are earth roads; the bridges and culverts are in the care of the road organization. It is also assumed that the town officials do not have charge of the maintenance or construction of sections of heavily traveled through roads, but that these form a part of a system under the maintenance of a State Highway Department.

The Town Road Commissioner—The entire responsibility for the work in the town should be in the hands of one commissioner. He should be elected for a term of three years, his pay should be a fixed percentage (about 10%) of the regular road and bridge levy of the town, but in no case less than $200 per year or exceeding $500.

His duties should be administrative only and require but one or two days time a month on an average. There should be one fixed day each month when he may be found at a designated office in the town, on which days contracts should be let and other business transacted. The commissioner should be required by law to let all contracts for road and bridge work after public advertisements and at public lettings, and upon properly prepared plans and specifications. He should also be required to purchase all supplies amounting to more than a certain maximum in any month by advertisement and public letting of contract. He should be custodian of the town road funds. He should have full charge of all road work in the town, make all contracts for road work and for bridges for the township and should be obliged to employ or appoint a road superintendent who would be responsible only to him. The road superintendent should be employed by the year on a monthly wage basis, being required to give his entire time to road work. He should be custodian of the equipment owned by the town and be responsible for its care and upkeep. He should have authority to hire such men and teams as may be necessary, subject only to approval of the town road commissioner.

Provisions should also be made by law for the proper engineering supervision of any work done in the town which requires technical skill not to be expected of the commissioner or of the road superintendent.

The Working Force—The various classes of work that ought to be done in a township can be so arranged that a regular force of employees can be kept busy throughout those months of the year when weather conditions permit construction work. This force may be large or small, depending upon the condition of the roads in the town and the amount of traffic, and consequently the amount of maintenance necessary; but whether it be large or small, it should be maintained as nearly as possible throughout the construction season so as to take full advantage of the expertness and experience which the men will obtain in doing the class of work required of them.

Several kinds of road work necessary in a town can be done about as well at one time of the year as another,

*Abstract of paper read at convention of American Road Builders' Association, Dec. 3, 1912.

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while other kinds ought to be done at certain seasons in the year as explained later in more detail.

Road Machinery—Some kinds of machinery that could be economically used in a larger geographical unit cannot be economically used in a town, since depreciation during a long period of inactivity will more than make up for the economies in their use for a short time.

County and Town Co-operation—To have available such engineering supervision and such equipment as are not practical for very small units, a larger organization than the town unit seems necessary—such as one for the county, and there should be a county highway engineer appointed by the county board to have general charge of all road and bridge work requiring engineering supervision. The county should own such expensive machinery like rollers, spreading machines for bituminous materials and concrete mixers, as might be efficiently employed on roads requiring such apparatus. This equipment should be under the immediate supervision of the county engineer and assigned by him for use in the different towns. Predetermined fixed per diem charges sufficient to operate and maintain this equipment should be ascertained by the county engineer and paid by the towns using the machinery.

The county engineer should draw and approve all plans for roads and bridges in the county exclusive of those upon the main system of roads, which are under direct control of a state highway department. The general specifications for all bridges should be furnished by this state department and followed by the county engineer in his designs for individual bridges.

The smaller concrete bridges that require only from 100 to 150 cu.yd. of concrete, could well be constructed by day labor under the immediate direction of the county engineer, the county to furnish on such work, a concrete mixer, special collapsible forms, where such can be used, and an inspector to superintend the work, this portion of the construction to fall upon the county; the cost of all labor and materials to be furnished by the town. The initiative for such work should be taken by the town commissioner.

Construction Work on Roads—All grading and shaping of earth roads should be done early in the season—beginning as soon as they have settled sufficiently to permit the use of proper machinery. The road superintendent should act as foreman, and be in immediate charge of the construction work and give his time continuously to it. The most approved and efficient methods should be employed—using a grader drawn by some sort of a power tractor; the work should be planned so as to inconvenience the public as little as possible.

If heavy grading, as in cuts or embankments, must be done, the work should be laid out and grade established by a competent engineer, and the road superintendent should then work to the grade so established, using teams and scrapers; and such work should be done as early in the season as practical, so as to permit the newly made embankments to be compacted before the winter season comes on. All such work can be conveniently done by day labor with the regular force employed in road work.

Construction of Hard Roads—Hard roads should be built by contract. Plans and specifications for the work should be prepared by a competent engineer and the construction should be caried out under suitable inspection by the engineer, or an inspector approved by him. The contracts should be let in early spring with provision for the completion of bituminous construction before the temperature drops below 60°.

Construction Work on Culverts—After the necessary earthwork on the roads has been completed, the force should take up the construction and repair of culverts. This work can be conveniently done in midsummer and early fall. At this time the streams are usually low and the work will be least interrupted.

In many instances the town might well adopt a general type of concrete culvert, thereby permitting the use of forms repeatedly, and making it unnecessary for the town force to become familiar with more than one general type of construction.

Construction of Bridges—The construction of all bridges or culverts having a span of 6 ft. or greater should be in accordance with general specifications established by the state highway department. The plans and specifications should be prepared during the winter, and the contracts let in the early spring. The construction of the bridges should be carried out under the supervision of an inspector and the approval of a competent engineer.

Maintenance of Earth Roads—After the earth road work has been completed in the early summer, a certain amount of grading will be necessary in order to maintain the proper shape to the roads during settlement. Such work can usually be done by teams and a light grader, and arrangements should be made by the town road superintendent to follow up new work to maintain the surface and general shape of the roads until the roadway has become thoroughly compacted.

In addition to the maintenance work which can be done with a small grader, there will be a large amount of maintenance work to be done by means of the split log or other similar forms of drag. Inasmuch as the dragging must usually be done throughout the town within a period of a few hours, if the work is to be done while the soil is in proper condition, it will be necessary for the road superintendent to have men who live in various parts of the township employed for this purpose with the understanding that they will drag certain sections of road immediately upon receipt of notice from the superintendent.

A perfect system of drainage on all roads is important throughout the year. It is particularly desirable to have the roads enter the winter-and-spring period without obstructions to drainage anywhere. Late in the fall, all culverts should be cleaned out, weeds and grass removed from the ends and the ditches along the roads throughout carefully cleared and opened so as to insure a free flow of water to the culverts and outlets.

Patrolling Roads—The road superintendent should patrol the main traveled roads in the town at least once a week. All of the roads in the town except possibly a few infrequently traveled byroads, should be patrolled once a month. Special inspection trips may be necessary to sections reported as being in improper condition.

Franchises for Rights of Way—No franchise for rights-of-way within the public highways should be at the disposal of so small a unit as the town, but this authority could well be extended under proper limitations, to the county boards. Franchises for electric railroads within the limits of a highway should be prohibited by law except within the limits of incorporated villages and cities.

Reminiscences of an Electric-Railway Engineer*

By S. W. Huff†

I have been given the subject of street-railroad development. This is a broad subject and if I feel a disinclination to follow a strictly technical discussion of it, I am equally disinclined to follow a strictly historical discussion of it on your account as well as my own. I have thought, however, that I might perchance be able to interest you in some of the early incidents of street-railway development with which I came personally in contact.

It has been something over twenty years since, as it were, I broke in upon Sibley College. I had had a college course and after teaching two years, one of which was in a mechanical school, I conceived the very prevalent idea at that time that "electricity was the coming thing," and having had the usual experience in bell and burglar-alarm wiring, I decided that I wanted to learn electricity and that Cornell was the place to learn it.

After a correspondence with Dr. Thurston, in which I explained that my previous college work would not fit in with the requirements for the regular course in mechanical engineering and that I had neither time nor money to spend in getting up back work, he consented to allow me to register as a special in Mechanic Arts and select my work.

We men of that period did not have present advantages, yet the personality of the instruction, which after all is a very important factor, was strong and deep and progressive, and the equipment was good for the period, probably surpassing any other similar institution.

With a Pioneer Road

At the beginning of the summer vacation of 1890 my attention was called to the fact that the operators of the pioneer electric railroad in Richmond, Va., had announced to the city authorities that after a thorough test, they were forced to admit that electricity as a means of propelling cars was a failure and they wanted time in which to provide some other means for the operation of their cars. I knew that the road had but a short time before been turned over by the Sprague company, and was of necessity an interesting point of operation at that time. Accordingly I went to Richmond and applied for work.

The superintendent had but recently taken charge, having previously been in charge of a small steam dummy line and was utterly ignorant of electrical work. Mr. Mason, one of the Sprague experts, who afterward upon the organization of a street-railway department by the Westinghouse company, became its chief engineer, was there trying to get the road in operating condition. He told me that things were in wretched condition, but if I wanted to learn that was the place above all others, as anything that could happen anywhere was happening there every day.

When I offered my services to the superintendent I had to admit that I had just come from college, in fact hoped to go back there again in the fall, and he could not see how I could be of any service. I insisted, however, that he must need laborers, and that I was willing to tackle laboring work in order to get in. But while a negro would have been readily employed, he was very loath to take me. By insistence, however, I finally succeeded in being enrolled as a laborer at a dollar a day and went to work the next morning.

(Much to my regret when I became general manager of the combined railway and lighting properties in Richmond some twelve years later, I was forced to dispense with the services of this old superintendent. He had been unable to learn, but with native ability in other directions had been able up to that time to first *run* and then *run away* anybody who had become connected with the company that was capable of helping in its development. Just here I will say that somewhere in this broad land there is some practical old fellow laying for you and sooner or later you will meet him, and have either to unhorse him or be unhorsed by him.)

But to return to my story; it was a very few months after the Sprague company had completed its experiments in Richmond, and turned the road over to the local company. So that although I cannot claim to have been present at the birth of this electric street car, I was present at the time it began to crawl and had a share in its nursing.

The period of experiment had spoiled everybody. It had been a period of hope and despair. If a man made a round trip with a car, he might reasonably expect an overcoat or a suit of clothes as a bonus. The men in the shop had become equally spoiled, and would do only that work which was absolutely required of them. Those who wanted to do honest work had little encouragement.

I was placed under one of the walking bosses out in the car barn. After completing a minor piece of work that had been assigned us, he ordered me to come along with him and after walking around for some time I stopped to look at something, and he ordered me to come on, with the remark that if we did not keep walking and keep out of the way the general foreman would come along and give us something to do. I suggested that probably this was the reason he was called a *walking boss*.

With 40 cars equipped and turned over by the Sprague company, the regular schedule called for only 13, and it was with the greatest difficulty and most strenuous work on the part of Mr. Mason that we could keep 13 out on the road. There had been times in which there were only one or two cars in operation. The cars had been used for horse-railway service. The motors were rated at 7½ hp., two of them to a car. The grades were as high as 10%, one of 9% being on a curve.

The motor then being operated was known as the Sprague No. 5. It was a flat two-pole type with four field coils and designed to operate on a 24-in. wheel. The motors had been designed originally for single reduction, but Mr. Sprague found that the speed was too great and an intermediate pinion and gear were cast together and mounted on a stud set into the frame. The pinion engaged with a shell gear, making a double reduction motor, and reduced the speed approximately four to one over the original design. The connections between the wheels and body of the car were

*Condensed from an address before the students of Sibley College, Cornell University, printed in the "Sibley Journal" for October.

†President, Brooklyn & Coney Island R.R., New York City.

what were known as gears, simply a pedestal bearing. The motor was mounted on the axle as at the present time, but the nose attachment hung from the car body by means of a bolt through the cross sill; that was before the day of street-car trucks.

The armature had a commutator on each end so connected that there was but one brush on each commutator, and that on the top of the motor so it would be readily reached. Up to that time carbon brushes were unknown and copper brushes were used, set at a very considerable angle. You can imagine the result of a rough commutator running in the reverse direction against these brushes. A man was kept on the corner in front of the shop and every time a car made a round trip, first one and then the other motor was cut out and the car was run backward and forward while he filed the commutator with a coarse file.

The four field cores formed a part of the frame of the motor, and were set in this frame with bolts and dowel pins. The field coils required constant rewinding, and in putting them together again it was usually necessary for us to drive them up with a sledge hammer. I never understood why we had so much trouble in putting them together until years afterward when Mr. Sprague referred to the fact that one of the troubles of the early experiments was by reason of their not having used jigs for making their motor parts. These parts were consequently not interchangeable; we had been interchanging them with a sledge hammer.

Each field was wound in three sections, making it possible to vary the speed of the motor by varying the combinations of these fields. As I recall it, the resistance at that time was only used at starting.

The armature cores were of the smooth solid-core type, with the armature windings wound in by hand between fibre wedges at the corners and insulated paper in between. It took five armature winders to keep the 13 cars running—in fact we considered ourselves fortunate to keep the required number of cars running regardless of the amount of help or the expense involved.

After getting away from my walking boss and spending several weeks in the pit and machine shop, I got in touch with a man in the armature room who was a civil engineer by profession, but had yielded to the persuasive call of electricity, and was tiding over a period of hard luck by winding armatures. He offered to teach me how to wind if I could get in the armature room. The other man refused to teach any one, as they confidently expected to confine the business to their immediate group. The old superintendent, with an eye to business and the wages he was paying me, agreed to let me go in, but was very much horrified the next day to find me winding an armature, as he had expected me to spend several months sweeping the floor and *"learning the business"* before I began to wind. But my friend persuaded him to let me keep on. He told me, however, that if that armature did not run, down would go my house. The armature did run but down went the bearings a few days after it started and stripped the armature. So I do not know how long it would have run if it had been allowed a natural life.

During the summer, the Sprague No. 6 motor was brought out, and a few of them were installed upon this line with very much better results. The old equipment not only suffered from poor general construction but was too small, which resulted in the constant burning out of armature and fields. No. 6 was a 15-hp. motor, making the equipment of each car 30 hp.

Other Early Developments

At this time the overhead construction was somewhat similar to that of the present time, although I was told that the first construction consisted of rods on the curves rather than wires with pull-offs at intervals.

The Daft company was at this time operating a two-car line on the main street of Ithaca with two overhead trolley wires, and a little truck running on top of these wires taking and returning the current. The truck was connected by a flexible connector to a switch under the hood of the car, and when the motormen met at the turnout in the middle of the street they exchanged trolleys, so that each truck ran backward and forward up to this turnout.

The Thomson-Houston company, the other principal company, was operating the Soldiers' Home & Eckington road out of Washington. The Westinghouse company had not then entered the field. The Sprague and the Thomson-Houston companies were radically different in their systems of distribution and car equipment. The Thomson-Houston company put up no feeders, but varied the size of its trolley as more or less carrying capacity was required, the trolley being larger toward the power house and smaller at a distance from the power house; the Sprague system used a uniform size of trolley wire, and fed this trolley by feeders as at the present time.

There was much discussion at this time as to the relative desirability of the two systems, from which you can readily understand what a feeble comprehension we had at that period of the gigantic part electric traction was to play in the transportation of the future. Think of the feeder capacity of today at many localities in our cities being concentrated in one trolley wire and what the size of that wire would be.

The Sprague people used a system of commutated fields and a controller switch to vary the speed of the motor, while the Thomson-Houston Co. varied the speed entirely by resistance. This resistance consisted of a series of plates insulated from each other, and over the edge of which moved a connecting arm actuated by a cable operated from the front platform by a crank handle very much similar to the present brake handle.

In Manufacturing

The whole country was enthusiastic over the possibilities of electric development, and the so called practical men who had come in contact with electrical work, although very remotely, were greatly in demand. Richmond mechanical circles had early gotten the fever. An inventor who had been molding commutator sections and trolley wheels for the Sprague road, conceived the idea of substituting three fields for each of the fields in Sprague's original No. 5 motor, making 12 in all, and passing a countershaft through the space between the three fields, thus doing away with the stud attachment for reducing the speed of the Sprague motor. He built one motor of this description, put it on a car and with a party of small capitalists on board undertook to operate around a curve on a 9% grade. Naturally the car spun the wheels, as any other single-motor car would

have done under similar conditions. The inventor exclaimed upon the wonderful power of his motor as demonstrated by its ability to spin the wheels, and forthwith a company was organized to build electric motors for street railways and other purposes.

This practical mechanic felt some need of scientific assistance in this work, and about the middle of the summer I was offered the position of electrical engineer of this promising company at a salary of $13.50 per week, which I readily accepted. The company had acquired the use of a 50-hp. waterwheel to which they had attached a 220-volt generator and begun the sale of current in this city. To further this use of current, it was to manufacture motors for sale to its patrons, and I began upon the design of these motors first.

I had not up to that time reached motor designing in my course in Cornell, and I had the toughest job that I have ever tackled. I purchased all the books I could find on the subject of motor and generator design, which were very few at that time, and waded into them on hot summer nights. I was not very well prepared to understand what I was reading, and I became firmly convinced that the authors for the most part were using mathematics that they themselves did not know how to apply.

All the time I was trying to find out how to design the motors, the foreman of the machine shop (we had a very well equipped small shop) was calling for drawings and bills of material. Finally I got a stationary motor started in the shop, which by trial windings I succeeded in getting to run fairly well. But things were moving so fast that the inventor was unwilling to stop at small things, and insisted upon taking a contract to build railway motors and equip a street railroad upon which there were several grades as high as 18%, this with a capitalization of the company of $10,000, only a portion of which had been paid in.

I demurred at this, but the inventor assured the board that he had millions in his mind, and only needed an aggressive policy to realize it. He said that I was disposed to hold back and intimated that this was due largely to the fact that I did not know how to go ahead, which was very true. On the board were several good business men who sided with me, but the majority felt that no matter how impossible it might seem, the magic word electricity was sufficient to carry the enterprise through, and I was out-voted and invited to resign.

Years afterward I met one of the directors who voted against me, and he was bemoaning the loss of his money in the company and reproaching himself for not having followed my advice in the matter. I assured him that he need not reproach himself on that account, as he would have as surely lost his money if he had followed my advice as by acting contrary to it, as it was only a question of time under either policy. The experience of this company is but an illustration of the many visionary electrical companies that were organized about that time, and the reckless manner in which they were handled.

The fall term at Cornell had already passed and I returned with the beginning of the winter term. I found that the class had been going over, in motor and generator design, very much the same work I had been doing in Richmond, but not under the same pressure. With a little assistance from instructors who were interested in the practical work I had been doing, I took my place in the class and enjoyed the work of the winter term immensely.

Although the facilities at Cornell were, we claimed, much ahead of similar institutions, they were limited as compared with what is enjoyed at the present day. In order to make tests of motors or generators, it was necessary for us to find sufficient pairs of wires on the switchboard in the dynamo room connecting with the instrument room of the physical laboratory, and a large portion of the squad engaged in the tests were located in this isolated room reading instruments, and it was not for several days after the tests, when the formulas and constants had been applied, that we really knew what the readings were or what we had been doing. The day of portable instruments and facilities for rapid testing had not yet arrived. To those of us who had had some experience in practical operation, this proceedure was tantalizing.

It was a period of rapid development and an intensely interesting one. Students were not following well beaten paths, but with discoveries on all sides were rushing headlong into an unknown field, ably led and stimulated by an enthusiastic corps of instructors and professors. I remember that I saw carbon brushes in use for the first time during that winter, and learned that armature reaction (which had but recently been discovered) played an important part in the motor and generator designs of that period.

The fact that the electric cars of that period as a rule carried all their weight on driving wheels, and the further fact that the uniform rotary pull of the motor was less liable to slip wheels than the irregular pull of a locomotive, had impressed every one with the wonderful climbing power of electrically propelled cars. There was much discussion as to whether the current passing down from the wheels into the rail did not have much to do with this. In some cases locomotives were fitted with generators, passing current down into the rail to increase the traction of the locomotive. I remember that quite an elaborate series of experiments were made at the university during that year to demonstrate what effect this flow of current would have; it was concluded that it was negligible.

When the spring vacation arrived, as I was not to get a degree (being a special student), as the remainder of the class were to apply themselves largely to experiments for the preparation of a thesis, and as my money and time were limited, I decided it would be a good plan to strike out and try and get a job before the market was flooded with the electrical engineers who were to come out in June.

Accordingly after much effort I secured a position with the Baxter Electric Motor Co., at Baltimore, Md., at $50 per month. (I mention these liberal retainers so you may not become discouraged when you secure your first positions.) This company had been one of the pioneers in the manufacture and installation of arc-light-circuit motors, and Mr. Baxter was one of the best known electric designers of that day. Some time before this he had published the design of a motor to be installed in each wheel of a car. The motor was never built; he had discovered that the commutation of a

large two-pole machine was very difficult, and he had taken the somewhat extreme position of designing a street-railway motor with eight poles in order to get a single reduction motor.

We claimed that this was the first single-reduction street-car motor built, and I am inclined to think the claim was justified. Up to that time cast iron was used almost exclusively for pole pieces and frames, the permeability of cast steel not having then been discovered; in order to make this motor light, the pole pieces and field cores as well as the armature cores were built up of soft iron sheet.

An experimental motor was exhibited to a group of capitalists, after which a champagne and terrapin supper was served, and the company launched upon its career with a large board of directors composed almost entirely of millionaires. In the early days it was thought that electrical enterprises could not be handled on the same business basis as other enterprises, as it was felt that capitalists did not understand anything about electricity.

Upon reaching the Baxter factory I found a magnificent shop building extending the entire length of a city block, together with much yard space, with the unassembled parts of fifty car equipments scattered over the floor, and not a man in the shop who had any street-railway experience. (I had gotten my employment upon the strength of my Richmond experience and not upon my Cornell training, as at that period and for many years afterward those in authority were very much afraid of college-trained men.)

Within ten days I was put in charge of the electrical department of the factory with some fifty electricians under me, but at the same pay of $50 per month, while many of the men under me were getting much more. They found that I was a college man and felt that a college man ought to be glad of a chance to work at any price.

We had orders for car equipments at something like $5000 per car and an equal amount of stock in the roads, and there were high hopes for great profits. When the first equipment was assembled it ran beautifully—until I put on a heavy load, when the motors would flash over at the commutators. The inventor and I thrashed over the situation, and decided there was something the matter with the brush holders. I tried every thinkable experiment in that direction without much improvement. Then I took the potential between the commutator bars around the commutator, and found that the difference between bars was very high, and that there was a very narrow space of low potential. I then went to work to trim the pole pieces with a view of widening out the space of low potential and succeeded to some extent in this.

The inventor and myself soon realized that the main trouble was that in designing an *eight-pole* machine a sufficiently large commutator had not been provided. In fact, as I remember, there were only about 17 bars between the brushes, which made an abnormally high potential between bars. The floor was full of armatures and the superintendent and inventor insisted that the capitalists behind the enterprise would not stand for redesigning of the armature at that time, that they could not understand, and that we must make it work as it was.

After making every improvement we could think of without a redesign, we laid off a large part of the men in the shop, and I went out on the road with some of the equipments. You can imagine the joy of the expert riding on the platform and keeping himself forever braced for fear of being thrown over the dashboard when the motor short-circuited and the car bucked.

We usually took three men to operate the car, one man to clean the commutator while the others ran the car. There was only a short line operating in Baltimore at that time, and these motors were experimented with on this line as well as on lines in Richmond, Washington and other places. After several months of experiment we prevailed upon the management to allow us to redesign the motor, and we put on a commutator a third larger. After that we got fairly good results with the motor, although there were mechanical defects that were serious, notably the slight clearance between armature and fields, which the inventor had fixed at $\frac{1}{64}$ in. This he insisted could not be increased or his calculations would be thrown out. Of course the armature got down on the poles and cut the bands off. I remember once sitting on the floor of a car in Washington, D. C., pulling out the band wire as the car ran until I had a large pile beside me. The passengers always viewed these experiments with remarkably good nature, and appeared to be considerably interested in the proceedings.

Things had been moving rapidly and no sooner had the single reduction motor been reached than several inventors went straight at the designing of a gearless motor. The Baxter company built one which I tested with fairly good results on our experimental track in the yard, but it was never put out on the road. The Short people, who were then prominent in the manufacture of motors, built one or more that were in service for a while, but not with very much success.

In Railway Operation

The Baxter company becoming inactive, and being offered a title and better salary to manage the little electric road in Raleigh, N. C., I accepted and had my first transportation experience. Two years later, upon the reorganization of the Baxter company, I returned as general superintendent. I timed and priced several equipments through the shop, and got the shop generally on a basis for aggressive commercial work.

By this time cast steel was being used for cores and polepieces with good results and, although the Baxter motor was a reasonably good one, it was necessarily expensive because of its mode of construction. Just at this time due to the severe competition between Westinghouse and the General Electric companies, which which were then the principal builders, the price of motors dropped to a very low figure, probably lower than they are today. In view of this I was forced to advise the capitalists, who were about to refinance the Baxter company, that the prospects for speedy returns upon new money invested in the company were not very good. Accordingly they decided to close up their electrical business, organize a land company and split up the land upon which their car tracks were located

into building lots. This real estate deal more than paid back the money they had sunk in electrical experiments. So far as I know this is only one of the numerous early electrical companies that went to the wall (and they nearly all did) by which the promoters did not lose their money.

Car equipments were being rapidly whipped into commercial shape. The Westinghouse company had brought out its "12-A" and "49" motors, and the General Electric company had brought out its "G. E. 800" and its "G. E. 1000," all of the present closed type. Mr. Potter (of the General Electric Co.) had developed the "K type" of magnetic-blowout series-parallel car controller, which has been the only manual type that has stood the test of continued usage successfully.

The problem of light-car operation in cities seemed practically solved and engineers were looking to the electrification of steam roads and of heavier service. The New York, New Haven & Hartford had equipped its Nantasket Beach branch electrically and was handling heavy service successfully. A company was organized to build a high-speed heavy-service line between Baltimore and Washington, a distance of 40 miles, to compete with the two existing steam lines. Upon becoming electrical and mechanical engineer of this company I had before me some of the most interesting problems of that period.

The question of long-distance transmission was a serious one. A line supplied from high-tension alternating-current through rotary converters was being operated out of Lowell, Mass., but it was considered highly experimental, and neither our advisers or the engineers of the electrical companies would recommend it strongly for our requirements. The General Electric company suggested the use of a three-wire system, one pair of motors of a four-motor equipment being operated on a positive trolley and the other pair on a negative trolley, the track being the neutral wire. After much discussion this plan was adopted by the board. But due to the claim of the company that its patents gave it exclusive use of this system, the question was again opened to give the Westinghouse company a chance. After much discussion, the booster system was finally adopted, although the financial panic of 1896 prevented its ever being put into use.

The letting of contracts of importance at that date was surrounded by so much wire pulling and influence of all kinds that it was very difficult for a young engineer to hold his own against the conflicting influences. I soon recognized that, aside from the important mechanical questions involved in the design of power houses for this road, sooner or later I would find the pressure too strong for me to stand alone, and it would be the better part of wisdom to call in a consulting engineer, who not only could help me with the design and letting of contracts, but whose reputation would assist in withstanding the pressure. Accordingly I got Prof. Carpenter to agree to act as consulting engineer for the company.

We took up in detail each item of machinery required in the power houses, and let the contracts separately, and I got about the best year of post-graduate work that a fellow could get at that time.

I must relate one incident to illustrate the fact that at that period (1896) college professors, as well as college-trained men, were looked upon with skepticism by those in contact with railroad matters.

A very successful agent for one of the most prominent street-railway engine builders of that period was located in Baltimore, and had confidently expected to get the contract. Matters had been delayed; he was becoming impatient and finally rushed into the office very much exercised and told me that he had just heard that a man by the name of Carpenter, a college professor, had been called in as consulting engineer, and intimated that he might withdraw his bid if his engine was to be passed upon by such theoretical people. The next day he came in with quite a different manner, and handed me a telegram, saying, "What do you think of that as a throw down for a man who has been selling engines for years and thought he was at the head of his profession?" The telegram was from the proprietor and designer of his engine company and read:

> Prof. Carpenter is all right, but you need somebody there who knows something about engines. I will be down on the night train.

The next work of special interest for operating engineers was the harmonizing and rounding into shape of the various equipment that came in from the various small roads as they began to be consolidated into the city systems of today. I remember, as electrical and mechanical engineer of the United Railways of Baltimore, that besides having under my charge almost every type of motor and car that had been built in this country, there were nine power houses, no two of which had the same type of engine equipment; about everything in the shape of generators and boilers that had been built was represented. The operation of the turbine plant of today is simple as compared with the difficulty in keeping this heterogeneous collection running and hitched up to the trolley wire.

I could spend much time in speaking of the development of cars, tracks, trolleys, etc. The development of today has been reached after many tedious steps and much waste of time and money, and many things which today would seem to us absurd were undertaken then with the greatest earnestness and enthusiasm.

I recall the anxiety with which we bonded the rail joints with a piece of iron telegraph wire, and made this fast to a small iron messenger ground wire, this wire being grounded carefully at frequent intervals. We were very anxious to get good contact with the earth, and I remember my own surprise when I discovered that the road ran about as well with the ground wire disconnected.

The builders of the Sprague road in Richmond drove a number of iron bars in the ground and connected the track with them, and some of them are there today; no wonder the expert who undertook to make a ground-potential and current-flow map of Richmond for electrolysis-cure purposes almost lost his mind in the attempt.

Those of you who take up electric traction have before you an intensely interesting prospect. You may not have the inspiration of the rapid development of an infant industry, yet even now this is not an old industry and there is unlimited work for well-trained earnest men and the day of your greatest opportunity

is but beginning. The day of the so called "practical" man in engineering work is rapidly passing, and the man of good training coupled with other requirements comes rapidly to the front.

Handling Men

There are some who look upon technical work, and even engineering, as but a stepping stone to what seems to you a broader field—a field of contact with men and affairs—a field in which you can multiply the efforts of your brains by the hands of many. I would urge you not to be in too great a hurry to rush into this field. If you have executive ability it will develop, and for successful work in this broader field, you need a fair experience with details. The requirements of the future will be more and more exacting, and you will save time by laying your foundations well and mastering fully the details which later you will require performed by others.

I do not believe any of you can handle men successfully and get the best results out of them without having a genuine interest in their welfare. You may have to stand firm against unjust demands and even pass through bloody strikes in order to maintain reasonable control over the operations of the property entrusted to your care. But if you are to get results with men and for men, you must not let these experiences, which are but incidents, imbitter you or cause you to lose your interest in the welfare of those whose labor you direct.

It is difficult to lay down any fast and hard rule for handling men. The ability seems to be inborn. I once heard a most successful track man say that a lazy man made the best kind of foreman, because a lazy man "fairly loved to see other men work." I don't believe great physical energy is essential in directing the work of large bodies of men, in fact, the over-energetic man who takes hold nervously and wants to do everything himself is seldom a success in organizing or handling men. Yet I don't believe a man who is mentally lazy will ever be a success in handling others. Freedom from physical exertion or, as one gets higher up in the scale, from details of administration, should only create greater activity in the mind, so that one may stimulate those under him to do their best.

Study and develop the individuality of your men, and don't try to fit men into a ready-made organization, but fit your organization to the individuality of your men. It is easier to adapt your organization to your men than to find men to fit a set organization.

Don't attempt to mislead the men under you as to your own ability. They are very much better judges of that than the men above you, and if there is one essential in winning and holding the confidence of the men under you, it is honesty toward them and justice in your dealings with them.

Relations with the Public

Those of you who select electric-traction work will find an ample opportunity to develop the best that is in you in your efforts to meet the necessities of operation, and at the same time meet the requirements of the people and the municipal authorities. Yet no matter how unpromising the prospects may appear at times, an abiding faith in the justice of your cause, and a determination to make your case appear as it really is, will win in the end. If you have absolute faith in the justice of your cause, take it to the people and keep it there until it is recognized.

I don't mean by this that every popular clamor of the times is just or should be heeded. There are times when you have to stem popular clamor, but you can rest assured if you are right it will turn with you in the end. I had a forcible illustration of this some years ago. I lived in a suburban municipality, and had just passed through a very bitter street-car strike in which the destruction of my house and family had been threatened. The house, by the way, that I lived in belonged to the mayor of the town, and when it was threatened with destruction by fire you can imagine how promptly he got busy. The people of the community showed a sympathetic and neighborly spirit which I much appreciated, and at a meeting of their improvement association, I thanked them for their kindness and promised them that the very slow and inefficient car service that they then had would be greatly improved.

Some months afterward we re-equipped the line with new four-motor cars, and cut the running time in half—that is, getting the people to the city in just half the time. Under the old, slow service they had been able to sight a car out of a certain window, take their time to go to the corner, and after exchanging greetings with their neighbors, take the car and make a leisurely trip to town. Under the new service, it was necessary for the crew to waste no time, with the result that probably half the people missed their car the first morning and a large per cent. of them for some time afterward. The motormen who had previously been on that line were naturally averse to doing double the work, and I had to make some changes in crews in order to run the service, which further added to the complication.

The result was that within a few days I had a perfect storm around my ears. Men whom I knew intimately and in whose judgment I had great faith, called me up and protested against the service most indignantly, and there seemed little abatement of this dissatisfaction. I was satisfied that the service was infinitely better, but the protest was so bitter that I was almost on the verge of returning to the old schedule, when I talked the matter over with a newspaper friend of mine, and he suggested that I let him write an article, referring to this new and rapid service, but intimating that the town itself was most too slow to appreciate the service. This he did in a very adroit way. The criticism stopped, and in a few months the town had taken on new life and was enthusiastic over its service. Bonds were floated for the improvement of sidewalks, the building of new houses went ahead rapidly, and shortly it was necessary to double the service in order to accomodate the travel.

The Pearl Harbor Drydock at Honolulu, H. I., will be ready early in 1915, according to statements of the Navy Department. This date is later than that originally fixed, on account of changes in plan to accommodate vessels of 1000 ft., the limit of the Panama Canal locks, and on account also of the difficulties experienced in finding a suitable foundation in the coral rock. An attempt was made to utilize this coral rock as the aggregate for the concrete of the walls of the dock, but the concrete so made did not prove strong enough so it was finally decided after experiments to use parts of the coral sand and rock with a large amount of aggregate obtained from the Pacific Coast of the United States.

Automatic Block Signals for Single Track; C., I. & L. Ry.

The use of the block system on single-track railways is increasing, and its use involves the special problem of protection against opposing movements as well as following movements. The Chicago, Indianapolis & Louisville Ry. (the Monon Route) has completed an extensive installation of this kind, which is described below. The particulars are taken in part from a paper in the 1912 "Proceedings" of the Indiana Engineering Society, by E. G. Stradling, Signal Engineer of the railway, this being supplemented by information furnished us by the General Railway Signal Co., of Rochester, N. Y., which supplied and installed the equipment. During the latter part of 1910, the railway management decided to install an automatic block-signal system between Hammond, Ind. (at the northern or Chicago end of the line) and Indianapolis. The distance is about 163 miles, and there are about 340 signal blades in this district. Construction was commenced in July, 1911, and completed in March, 1912. The estimated cost was about $1100 per mile, including everything in connection with the automatic block signals and also the necessary alterations at the interlocking plants.

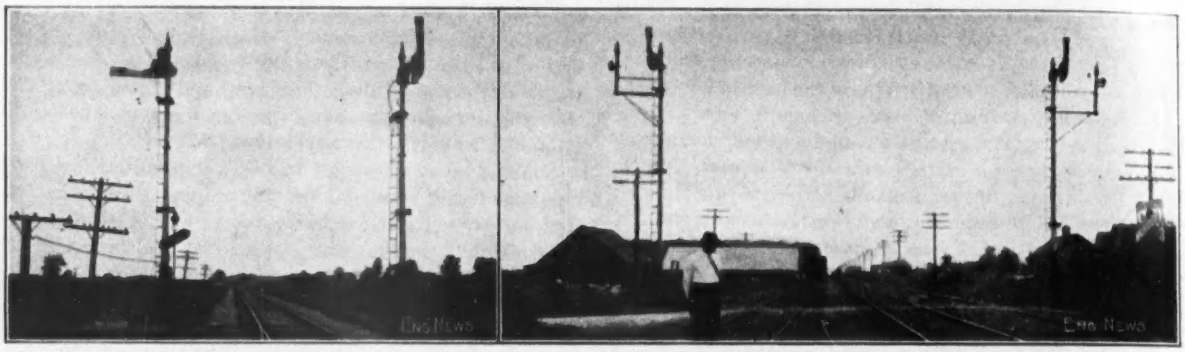

FIG. 1. STANDARD ARRANGEMENT OF AUTOMATIC BLOCK SIGNALS AT EACH END OF PASSING SIDINGS

FIG. 3. HOME SIGNALS ON SEPARATE POSTS
(With brackets and stub posts on account of a siding between the track governed and the signal post.)

SIGNALS

The two-position type of semaphore signal was adopted, though the signal mechanisms are so arranged that they can be altered so as to operate three-position signals. The semaphore blade moves from its horizontal position through an arc of 90° in counter-clockwise direction in the upper right-hand quadrant. The vertical position means "proceed," in all cases. The horizontal position means "stop" only when the semaphore is a home signal. For the distant signal the horizontal position means "proceed under control." The home and distant signals are distinguished from each other by the color and shape of the semaphore blades; the home signal being red with a square end, while the distant signal is yellow with a fish-tail end.

LOCATION OF SIGNALS

The road being single track, it was decided that the signals should be located near the switches to the passing tracks. Therefore, at each end of each passing track there are placed two home signals, the two signals being on opposite sides of the track so as to govern trains in each direction. This standard arrangement is shown in Fig. 1, which represents the signals at the north end of the passing track at Sheridan, Ind. In the foreground is the switch, with its switchstand in advance of the signal. The cable running from the box on the post to the short pole at the left is the connection from the pole line to the signal. The signal at the right, governing movements from this point to the stretch of single track beyond, is shown in the "clear" or "proceed" position. Consequently, the signal at the left indicates "stop," which position is indicated also by the corresponding distant signal.

Fig. 2 shows a special bracket-post arrangement of signals at Horton, Ind. This is made necessary by close proximity to the station, so that a signal post on the left-hand side would interfere with the receiving and discharging of mail pouches at the mail crane shown just beyond the road crossing. At some points where a sid-

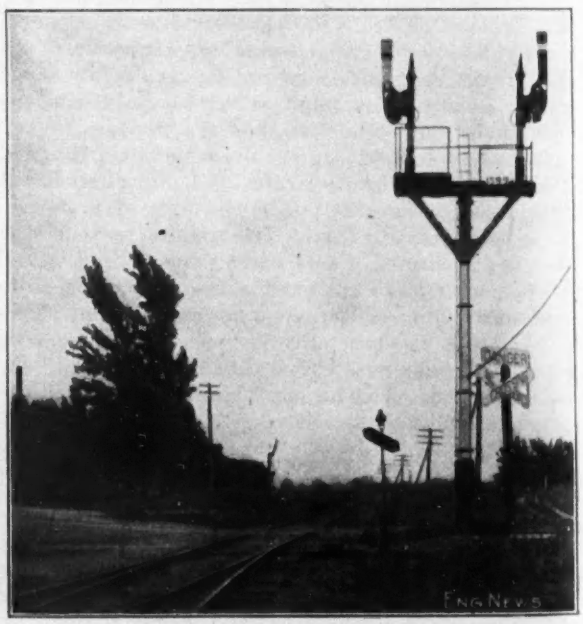

FIG. 2. BOTH HOME SIGNALS ON A BRACKET POST
(A post at the left side of the track would interfere with the use of the mail crane.)

ing intervenes between the signal and the main track, the signal posts are placed on opposite sides of the track, but each has a bracket arm with stub post and lamp to indicate the siding. This is shown in Fig. 3, which represents the installation at Rensselaer, Ind. Attention may be called to the crossing signs shown in Figs. 2 and 3. These are of the design required by the Indiana Railway Commission, having the word "Danger" in red letters on the board at the top of the sign.

In order to regulate the approach of trains to a passing track, a distant signal is located approximately half a mile from each end of the passing track. Fig. 4 shows the distant signal south of Horton, which is in the "clear" position, indicating that the home signal at the entrance of the passing siding (the left-hand blade in Fig. 2) is also at the "clear" position. A train receiving a "caution" signal, by the arm being horizontal, will reduce speed and arrive at the switch at the passing track under control, so that it can stop at the home signal and there meet an opposing train standing on the main track, the standing train having been stopped by the outgoing home signal. All that remains is for the train arriving last to enter the siding so that the other or opposing train may proceed.

In order to prevent two trains from leaving adjacent sidings simultaneously and meeting at some point between them, a set of intermediate home signals is placed between sidings. These signals are staggered on opposite sides of the track and about 3000 ft. apart, so that they will stop any two opposing trains by that distance. Fig. 5 shows an intermediate signal south of Monon (and between Monon and Guernsey). The signal governs northbound trains, and is set at the "stop" position against such trains as there is a southbound train in the section. It will be noted that all signals are numbered, those governing northbound trains having even numbers, while those governing southbound trains have odd numbers.

For following movements it was necessary to carry the control of each outgoing home signal some 3000 ft. beyond the next home signal. The overlap of 6000 ft. is necessary as a margin of safety.

Special Signal Arrangements

As in most problems of this character, there are some special cases. At Hammond, there is a long, narrow yard, and in order to make it safe for a yard engine to enter the main track, an electric lock was placed on the switch. This lock is controlled by the block system, and a train on the main track having passed the last stop signal will set the switch lock so that the switch cannot be opened.

Between South Hammond and Munster, the distance is so short that the distant signals in each case were placed on the outgoing signal, and the overlap carried into the next block. This eliminates the need of intermediate signals, but places a handicap on using Munster as a meeting point for trains.

At the junction at Monon it was necessary to arrange the signals to take care of trains for the Louisville line. This is done by having a set of signals selected by the position of the switch which is used by the Louisville trains. At Indianapolis, there is such a short distance between the north end of the yards and the passing track at the State-Fair grounds that the distant signals in this case were carried back and placed on the same poles as the intermediate signals.

Block and Interlocking Signals

One of the chief problems which arose was to operate the block signals through the interlocking plants. There are ten interlocking plants in this district and no two of them alike. It was necessary to mark the signals in some way so as to distinguish them from the block signals. Therefore, each home signal at an interlocking plant must have at least two home signal blades. The top blade on the pole is arranged so that it is both an in-

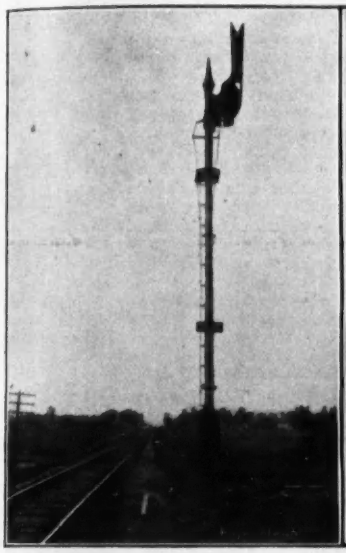

Fig. 4. Distant Signal

(Indicating position of home signal at the next passing siding. The signal indicates "Clear.")

Fig. 5. Intermediate Signal Between Passing Sidings

(The signal governs movements in opposition to the train shown, and is at the "stop" position as an opposing train is in the block section.)

Fig. 6. Three-arm Home Signal

(Governing approach to an interlocking plant and passing siding in rear of the train.)

terlocking signal and a block signal. The lower blade is known as a calling-on signal and is used to get a train over the derails when for some reason the block system prevents the top arm from being used.

At some of the interlocking plants a passing track is connected to the plant and handled by it. In such cases, the home signal regulating trains approaching the switch has three blades, as shown in Fig. 6, which represents the three-arm home signal at the Westfield interlocking plant. The top arm (semi-automatic) governs the main-track or high-speed route; the second-arm governs trains for the passing siding or diverging route; the third or bottom arm is the calling-on signal mentioned above.

By altering the interlocking plants so as to use upper-quadrant signals, a uniform type of signals was secured at all points. No new interlocking plants were installed in connection with the block-signal equipment, but the ten existing plants were overhauled, the mechanical work being performed by the railway company's forces and the route locking and electric work being handled by the signal company. A number of the home signals were slotted and route-locking installed at each of the mechanically operated interlocking plants.

Traffic Results of Block-System Operation

The installation of block signals has two important objects: 1, increased safety of traffic; 2, increased facilities or traffic capacity. In regard to the results of the automatic signal installation described above, we are informed that although these signals have been in service considerably less than a year, the freight trains are making much better time than they did under the manual-block system. This is due to the fact that now the trains can be run closer together with equal safety, which increases the traffic capacity on single track lines. There has not been any material increase in the number of trains hauled, but the fact that the trains can make so much better time than previously has made a considerable reduction in the overtime paid to the train crews, which previously accumulated on account of time lost while they were waiting on sidings. It may be noted also that with the installation of the automatic signals there was a decrease in the number of telegraph operators previously employed to operate the manual-block signals.

Protective Coatings for Railway Bridge Floors*

By A. W. Carpenter†

In the preservation of steel railway bridges from corrosion, the parts which offer the most difficulty are the tops of transverse floor members such as floor beams and transverse floor troughs, especially on bridges subject to the brine drippings from refrigerator cars. Quick drying is a very desirable quality for coatings for these parts, and considerable body is needed to resist abrasion and other mechanical damage.

Tar-Cement Coating

A coating possessing these qualities is one of coal-tar or coal-tar and portland cement, the preservative qualities of which are excellent. The tar, or tar and cement mixture, is applied hot with mops, and the immediate hardening process is due to cooling and not to drying, as the term is applied to paint. Refined coal-gas tar should be used, not water-gas tar. The surface to be coated must be clean and dry to insure adherence and protection. Where a priming coat of paint can be applied, it is recommended but is not essential.

The mixture of tar and cement is preferable for locations subject to the heat of the sun, as the cement hardens the coating, thereby increasing its resistance to flowing, and its alkaline nature should neutralize any acid in the tar. We have prepared this coating by first heating the tar in a kettle and then sifting into it from one-half to an equal volume of portland cement and boiling the mixture one or two hours before application. This coating has given excellent results on plane surfaces, but in many instances has failed to protect the rivet heads, which have been found to be specially difficult to protect in the difficult location under consideration.

Whether the use of a larger proportion of cement in the mixture would cause the coating to hold better on the rivet heads is not known, as little experimenting with different proportions of cement and tar has been done. On the flat surfaces of the floor beam and trough tops and on the vertical sides of troughs filled with ballast this coating has protected well for several years, except where burned by hot coals from locomotives or removed by mechanical means. This coating has been used for several years on the floor troughs of the Park Ave. viaduct, in New York City, a four-track structure 1¼ miles long. The coating is applied as the troughs are opened for the renewals, it being possible to clean and coat a trough and replace the ballast during the same day. The life of ties on this viaduct is about four years, for which period the coating promises to protect the steel. No refrigerator cars are operated over the viaduct, but there is considerable deflection in the floor, which is a probable cause of the short life of plain coatings previously applied.

The quick drying or hardening of the coating, and the heavy body, combined with its close adherence to the metal and the excellent preservative qualities, make it far superior to the paint coatings previously used, which would not protect longer than two years. A wash of neat cement grout, to be applied on top of the tar and cement coating has been suggested, and should assist in hardening the surface of the coating and in increasing its efficiency. The use of graveled surface roofing felt over the coating on top surfaces is being tried, as it protects the coating greatly from mechanical injury.

Cement-Mortar Coating

Our experiments with the tar and cement mixture and various other coatings included cement-mortar protection. The latter has proved the most successful for the tops of floor beams and troughs. It has been applied by mixing a stiff mortar of 1 part portland cement to 2 parts sand, and plastering this on the tops of the beams (after painting) to such a thickness as to cover the rivet heads at least ¼ in. A reinforcement of poultry netting in the mortar layer has been specified for each case, but generally omitted in the application. The top of this mortar layer has in some cases been covered with roofing felt, mopped in place with roofing pitch, the felt bending over the edges of the mortar to shed water. In other cases the felt has been omitted, but it should be applied, for waterproofing the mortar slab, the better protection of the tops of the rivet heads (which can generally have only a thin coating of mortar), and the general binding together of the mortar surface to prevent it from cracking.

The first service experiment with the mortar coating was made on the tops of the troughs of a double-track floor in 1908. The tops of these troughs had suffered considerably by corrosion in spite of frequent painting. The troughs have less than the desired strength, for which reason they are to be replaced shortly, and consequently the deflection of the floor is quite marked. In spite of this deflection the mortar coating, covered with roofing felt, has held intact to date, except where injured by track tools and by rails dropping on it in distributing new rails. In another case the mortar protection applied without wire reinforcement and both with and without felt covering, is intact and in perfect condition after one year in service. This is on the very stiff floor beams of an open-floor bridge.

Protecting Other Parts of Bridge Floors

The tops of the floor beams and troughs are not the only parts attacked by brine drippings, although perhaps the most susceptible generally, owing to the more exposed position. The bottom flanges and webs of the floor beams of open-floor bridges suffer also, although in less degree, being considerably protected by the deck and the top flanges. The top and bottom flanges of stringers and deck girders and the tops of lateral members suffer nearly as badly as the tops of floor beams. The mortar protection can be applied

*Abstract of a paper read at the annual meeting of the Maintenance-of-Way Master Painters Association, at Chicago, 1912.

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to the bottom flanges, where such a thickness can be used that the felt covering should not be required, and the surface can be sloped so as to drain quickly. Web surfaces have generally not been found to suffer so severely as flanges and it should be possible to protect them by paint without great difficulty.

The tops of stringers and deck girders carrying timber decks do not seem to offer favorable application for the mortar protection, which would have to be applied between the ties. We have been experimenting to a small extent with the tar and cement mixture on these. The use of galvanized iron or steel or of zinc sheet metal for a top flange covering on stringers and deck girders between the painted metal proper of the flanges and the ties has been suggested.

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A Large Cantilever Bridge in China

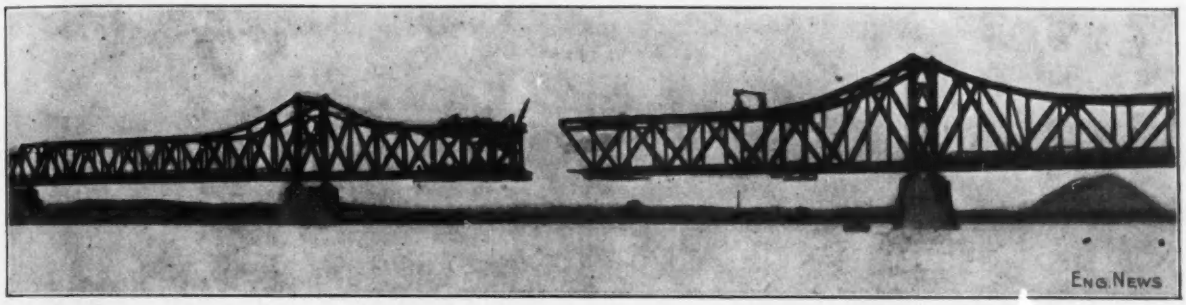
A cantilever bridge just completed crossing the Yellow River near Tsinanfu on the line of the Tientsin-Pukow River is remarkable in having not only an interesting cantilever span but also a very great total length of bridge, 4100 ft. It was built during the last three years by the Maschinenfabrik Augsburg-Nürnburg, of Germany. A brief general description given in *The Far Eastern Review*, of October, 1912, supplies the following data.

The bridge consists of nine spans of 300 ft. each, and a three-span cantilever structure comprising anchor arms of 420 ft. and a cantilever span of 540 ft. Eight of the approach spans are on the north bank and one on the south bank. The bridge is intended to carry ultimately two railway tracks (standard gage), but at present only one is laid, being placed in the center of the width of the bridge with footways along each side. The trusses are proportioned for only one track, and, when the other track is required duplicate trusses are to be added outside of the present ones, suitably connected to the old trusses. The railway loading for which the structure is designed is medium heavy, according to American standards.

The approach spans and the anchor spans were built on falsework, but the cantilever span was built by cantilever erection. The depth of the river, its very rapid current, the soft bottom and the variable river regimen combined to put falsework out of consideration for the channel span. For the same reasons the piers were difficult to construct, and represent as notable an element of the structure as the steelwork.

The low-water width of the river is about 1300 ft., but in flood times the water spreads out over the total width between the high-water dikes; the north dike is about a mile and a half from the river bank, while the south dike is close to the river. The flood discharge of the river is estimated at over 400,000 cu.ft. per sec., and the velocity of the current is nearly 15 ft. per sec. The region is entirely alluvial. The stream is notable for its shifting character. It has occupied its present bed less than a century, this being the location of an old stream whose bottom was found in the pier excavation to be about 55 ft. below the present low-water level. This bottom is hard, tough clay, above which is the alluvial deposit of the present river, a soft soil, the upper portion of which is constantly shifting.

The piers are concrete with stone facing, founded on reinforced-concrete piles (90 to 240 per pier), driven in open cylinders or coffer-dams (except the river piers). The general elevation of bottom of piles is 55 to 65 ft. below low-water level. The outer rows of piles were driven on a batter. The river piers were sunk as pneumatic caissons. The south main pier of the cantilever portion of the bridge, which is in the deepest part of the channel, was sunk to a depth of over 80 ft. below low-water level, or about 65 ft. below the river bottom. In the course of the sinking of this pier flood and freezing interfered considerably with the work. At one time the river was frozen from bank to bank solid enough to carry wagon traffic for a period of six weeks. Piles were driven in all piers except this one.



CANTILEVER SPAN OF YELLOW RIVER BRIDGE AT TSINANFU, CHINA, ON TIENTSIN-PUKOW RY.
(Closure of suspended span, October, 1912. The channel span is 540 ft. c. to c., consisting of 90-ft. cantilever arms and a 360-ft. suspended span.)

The superstructure consists of trusses of subdivided Warren type, with parallel chords, except that the top chord of the cantilever portion is up-curved toward the main piers to get extra depth. The roadway over the bridge is level on the cantilever span, while on the other spans it rises 0.67% toward the stream. Rail-level at mid-channel is 44 ft. above low-water level. The trusses are spaced 31 ft. As already noted, they are proportioned for the load of one track only and the second track when installed is to be provided for by building reinforcing trusses just outside the existing trusses. In that case brackets will be added outside of the trusses to carry the footways, which are now laid between the trusses, alongside the single track.

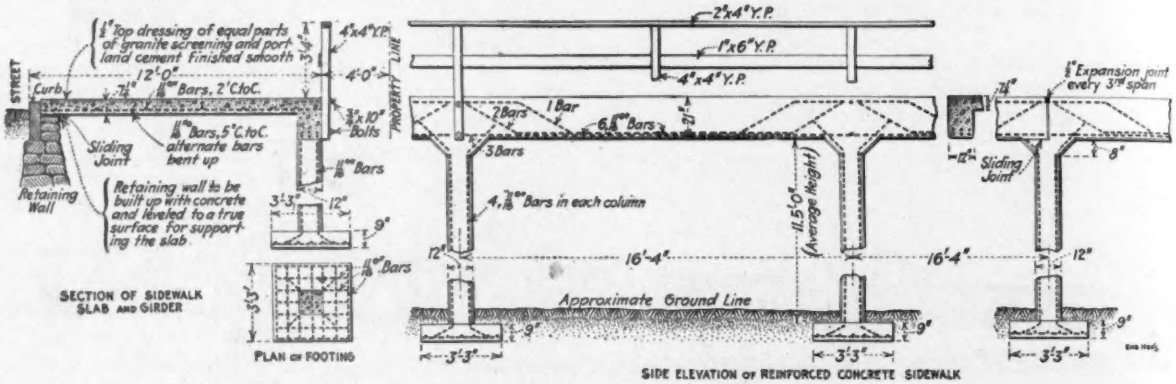
The proportioning of the cantilever span is rather unusual. Each cantilever arm is one-sixth of the span length; the suspended span, therefore, is two-thirds the cantilever span length, or 360 ft. This approximates to the proportion of greatest economy, and yet does not give an excessive length of suspended span.

Construction of the bridge was begun in August, 1909. The closure of the suspended span was made Oct. 9, 1912. The cost of the bridge is stated as 10,000,000 to 12,000,000 marks.

Reinforced-Concrete Elevated Sidewalks, East St. Louis, Ill.

By E. R. Rodenberg*

Before East St. Louis had adequate levees it was subject to annual inundation by the waters of the Mississippi River and Cahokia Creek. To overcome this the grades of the streets in the business section were raised above high water by filling between retaining walls of limestone masonry and paving with brick or granite blocks on this fill. The walls were set under the curb and no filling placed in the sidewalks space. This necessitated the construction of elevated sidewalks. Heretofore such sidewalks were constructed of wood or of "granitoid" arches between steel I-beams with one end resting on the retaining wall and the other end on columns or foundation walls of buildings. These columns were 18x18 in. in section and the maximum spacing being 8 ft., c. to c. they occupied a great deal of useful space and were very unsightly in appearance. When the wooden sidewalks on both sides of East Broadway from Fifth St. to Tenth St. became dilapidated and in need of renewal, City Engineer E. F. Harper recommended that reinforced-concrete sidewalks be constructed in place of the usual arch and steel-beam construction. The sidewalk shown in the accompanying sketch was designed by the City Engineer, assisted by the writer, approved by the Board of Local Improvements, ordered to be built by the City Council and is now under construction.



Details of Elevated Sidewalks at East St. Louis, Ill.

In the design a live load of 300 lb. per sq.ft. was used and all reinforcing bars are of the same cross-section to simplify placing the steel and avoid errors. A 1:2:4 concrete was used with a top dressing of equal parts of portland cement and granite screenings.

Although the space between the curb face and the property line is 16 ft., the walks are made only 12 ft. wide leaving a 4-ft. space in which the property owner may either place sidewalks lights or pave solid as he desires when constructing a building on his property. Openings, such as manholes for the delivery of coal to the basements, are placed as desired by the property owners, who furnish the cast-iron frames and covers.

The spacing of the columns is arranged so that the design can be used as a standard and three spans can be constructed in front of a 50-ft. lot without the columns encroaching upon the adjoining property. This is only important on work done by private contract with a property owner. As the work on Broadway is being paid for by special assessment under the Local Improvement Act of Illinois, no particular attention has been given to property lines in placing the columns.

A ½-in. expansion joint and a sliding joint have been placed at every fourth column. The joint between the slab and retaining wall is a sliding joint for the full length of the walk. The expansion joint extends entirely through the slab and girder and the upper 1½ in. is tapered, being ¾ in. at the top, and is calked with oakum and then filled with asphalt.

A 2x4-in. wood hand-rail supported by 4x4-in. wood posts 8 ft. 2 in. c. to c., is placed in front of vacant property and also where the buildings are set back from the property line. In the latter case openings are provided in the railing to permit entrance to the property. The posts are each fastened to the girder by two ¾-in. bolts embedded in the concrete.

The prices paid are as follows: Concrete $10.99 per cu.yd., steel in place $2.40 per 100 lb., excavation and backfill $0.62 per cu.yd., timber for railing, $51.02 per M. ft. B.M. The Murphy Construction Co., of East St. Louis, is the contractor.

*Assistant City Engineer, East St. Louis, Ill.

A Practical Question in the Technic of Water Bacteriology

While engineers seldom attempt to make bacterial examinations of water, yet they, in common with others having to do with public water-supplies, frequently find it necessary to interpret bacterial analyses. It will surprise many such engineers to know that two methods of bacterial incubation are now in use which are liable to give such highly different results that the mere totals of bacterial counts may mean little, in some cases, unless the incubation method used is known, and also unless the would-be interpreter is able to weigh the significance of variations resulting from the use of the two methods.

Without going into technical details, it may be explained that since the bacteria in water are too minute to be counted directly, even with a powerful microscope, it is necessary, if they be counted at all, to raise a whole crop of them on some favorable culture medium and count them by colonies instead of by individuals. To this end a tiny but known portion of water is deposited on a small plate of culture media and the plate thus "sown" is

placed in an incubator and kept there under constant temperature for a certain time. The plate is then removed and the number of colonies is counted. Each colony is taken to represent a single germ in the original sample. The results thus obtained are only approximate, but they serve as an index which is of value for comparative purposes—provided the methods employed conform, for each count, to a suitable standard.

Such a standard, in this case, involves uniformity of culture media and of temperature and time of incubation. Variations in any one of these materially affect the bacterial counts.

When, some thirty years ago, Robert Koch laid the foundations for modern water bacteriology, he employed gelatin as a culture medium. That medium is still in use, notwithstanding the marvelous advances in water bacteriology since that day. Other media have also been adopted, each with its advantages for varying kinds of samples to be examined, and particularly for different classes of bacteria to be counted.

In 1905, a committee on standard methods of water analysis, appointed some years before by the American Public Health Association, submitted a final report in which, among other things, it recommended that the standard culture medium for determining total numbers of bacteria in water should be nutrient gelatin, and that the standard for incubation period should be 48 hours at a temperature of 20° C. In 1911, the committee submitted a revised report (published in book form in 1912), in which, for the standard just given, it substituted agar as a culture medium, with an incubation period of 24 hours at 37° C. This change met with strong disapproval from many water bacteriologists.

At the recent meeting of the American Public Health Association, the pros and cons of the two standards were reviewed by Prof. George C. Whipple (Harvard University and 103 Park Ave., New York City). As a result of this and the discussion which followed, the following resolution was passed:

"Resolved that in the opinion of the Laboratory Section of the American Public Health Association, ordinary routine examinations of water for sanitary purposes, and in the control of purification plants for the present should include the determination of the number of bacteria developing at 20° and at 37°, and a presumptive test for B. coli in lactose bile."

The question of standards at issue is of particular interest to managers of water-purification plants. To learn the opinions of the latter, Professor Whipple wrote to about "twenty of the leading filter operators" of the country. Of the 18 who replied, eleven preferred the 20° gelatin count, four the 37° agar count, and three wished to test the methods side by side before expressnig an opinion.

The evidence from filter operators reviewed by Mr. Whipple in his paper is presented under the three heads, (1) convenience and (2) precision of the two tests, and (3) relative values of results under the two methods, as a guide in operating filters.

Convenience—Under this head the 37° agar method seems to have the weight of evidence on its side, some of the leading reasons being (a) the greater ease and accuracy of maintaining 37° as compared with 20° C., (b) the reduction of the incubation period by half, (c) and the fact that the higher temperature is required for B. Coli. tests, thus making it feasible to use one incubator for this and for the total count.

Precision—As reflecting the sanitary character of the water the evidence for and against the 37° agar count is conflicting.

Surprisingly few comparative data are available. Broadly, gelatin counts at 20° C. are much higher than the agar counts at 37°, the difference generally being decidedly more marked in polluted than in unpolluted waters. In addition, the relative differences are subject to seasonal variations.

(3) As a Guide in the Operation of Filter Plants—The principal objections of filter operators to the 37° count were that to change from 20° after it has been used a number of years would introduce unnecessary confusion [and evidently of far more importance—Ed.]; the 37° count would give such low results for many different effluents (often zero) that it would fail "to show slight differences in the operation of the plant." The 37° count might indicate a perfectly filtered and the 20° count an imperfectly filtered water. All this might matter little if the ratios between the counts at different temperatures were constant, but they are not.

Quoting now a brief paragraph from Mr. Whipple's paper, which also bears on the 37° count as a guide to filter operations:

"Another objection raised to the 37° count is that at present we do not know how to interpret the results. It is generally considered that filter effluents should contain less than 100 bacteria per cc., as shown by gelatin count. Who knows what would be the equivalent of this with the 37° count?"

General Conclusions—Mr. Whipple's conclusion is as follows:

"All things considered, it would appear to be unwise to change abruptly at this time from the 20° to the 37° count, as a guide in the operation of water-filtration plants. Before this is done, extended comparisons of the two methods should be made at many places and the data carefully analyzed to determine whether or not the change is advisable. Another reason against changing at this time is the possibility of using synthetic media in the future. All media composed of variable ingredients are unsatisfactory and bacteriologists are looking forward to the employment of media more definite in composition. Should such a change occur in the near future, it would be better to adhere to present methods until that comes about.

"It is recognized, of course, that the bacterial count has other uses than in connection with filter plants, and that for some of these uses the 37° count is undoubtedly superior to the 20° count. It is better, for example, for studying the purification of sewage, the contamination of shell fish, and for the analysis of milk. Possibly it would be wise not to have a single standard method for all of these purposes. At any rate it would appear to be advisable for the present, at least, to employ both the 20° and the 37° counts whenever practicable. This will require extra work, but if it is carried on systematically for a year, the data should be sufficient for determining whether the 20° count or the 37° count is most useful, or whether both should be constantly employed. Our laboratory section, through its committees, can confer no more useful service than to undertake such an investigation."

An Industrial Locomotive Driven by a Crude Oil Engine

Some interesting engineering problems were involved in an order placed several months ago with the C. W. Hunt Co., of West New Brighton, N. Y., for a locomotive for haulage service in the nitrate mining industry at Iquique, Chili. The preliminary design of this car was worked out by Messrs. Charles Wallace Hunt and Charles C. King, President and Chief Engineer respectively of the C. W. Hunt Co. Neither of these two gentlemen lived to see the locomotive completed but it is impressive evidence of their foresight and engineering ability, that the final design differed in no great degree from that indicated in their first skeleton drawings.

The conditions to be met were peculiar in several respects. The supply of bituminous coal in this region is very limited and its price ranges from $10 to $12 a ton. Water is also scarce and what there is available has a large content of mineral salts. The track for which the locomotive was desired is a narrow one (30-in. gage) and has many sharp curves. The grades are heavy, requiring a large tractive effort in the locomotive. Crude oil is plentiful in the neighborhood and can be obtained for about three cents a gallon.

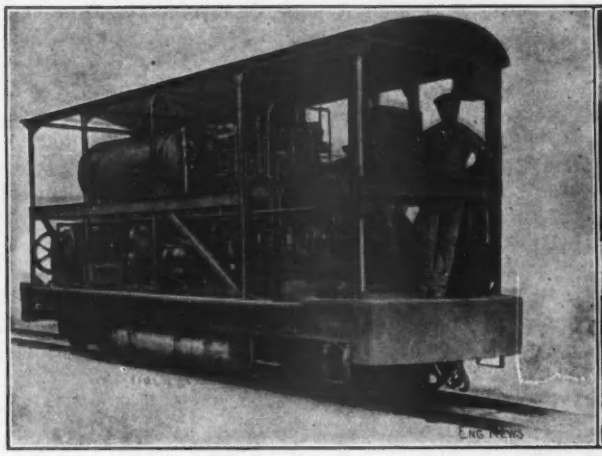
The excessive cost of coal and the scarcity of water, together with its undesirability for use in a boiler, precluded the possibility of using a steam-engine drive and the abundance and cheapness of crude oil led to the idea of using a crude-oil engine for the motive power. The fact that a high tractive effort was required of the locomotive made it necessary that each wheel should be a driving wheel, and because of the narrow track gage and many sharp turns (necessitating the use of a very short wheel base—or distance between wheel centers on each truck) it was evidently impossible to place any motor equipment directly on the axles, for lack of space.

After consideration of these controlling factors, it was finally decided to build a car in which a crude-oil engine would be used to drive a generator supplying current to two motors, the same being in turn direct connected to the four axles through drive chains and gears. It was thought that this arrangement would provide for all the requirements of the service at a moderate expense, and as a matter of fact the locomotive which was designed on this basis, and the important features of which are shown in Fig. 1 and described in the following paragraphs, did prove satisfactory and is in successful operation in Chili at this time.

Structural Features of the Locomotive

General Dimensions—The car is box-shaped, as shown, and is 25 ft. long, 10 ft. 9 in. high and 7 ft. 7 in. wide over the running board. Fully equipped, its weight is about 22 tons.

Framework—The frame is of structural shapes throughout, assembled according to standard practice and using the ordinary connections and rivet spacings. Twelve-inch, 30-lb. channels form the sides and 12-in. 20.5-lb. channels form the ends of the frame proper and between these the stationary upper parts of the two trucks are riveted. The bumpers of steel-sheathed timber are bolted to the end members. The engine and generator are supported on pairs of 5-in., 6.5-lb. channels so placed that the bed bolts pass between pairs of channels. Gusset plates at the corners, and the cross channels and truck housings, included between the side channels, provide against any possibility of twisting of the frame.



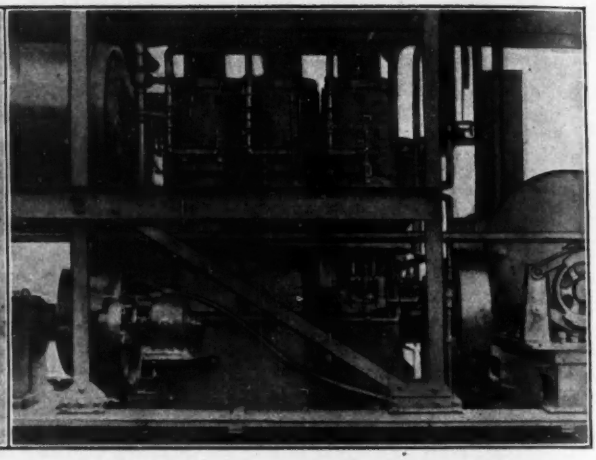


Fig. 1. Locomotive Driven by Crude-oil Engine, for a Chilian Nitrate Railway

Fig. 2. Three-cylinder Crude-oil Engine Mounted on Locomotive

(The C. W. Hunt Co., West New Brighton, N. Y., Builders.)

The floor of the car is about 2 ft. 9 in. above the rails, and from the floor project ten upright angle posts 3x2½ x$\frac{5}{16}$ in., 7 ft. 4 in. high, which support the curved canopy of No. 18 black sheet iron and provide a convenient means for supporting air-tanks, switchboard and other auxiliary equipment. A 6-in. channel railing runs all around the car except for the openings at the front end, left for the operator's convenience.

Engine—The motive power is supplied by a Meitz & Weiss vertical 3-cylinder, 2-cycle internal-combustion engine of 75-hp. rating, operating on crude oil. A view of the engine is shown in Fig. 2. The cylinders are 10 in. in diameter and 12 in. stroke. Ignition is effected by the hot-ball method. Compressed air is used to inject the fuel into the chamber at the end of the compression stroke and provision is made for feeding the steam, which is

generated in the water jacket, into the combustion chamber along with the air supply.

The engine is connected to the generator through a flexible coupling whose construction is shown in Fig. 3. This coupling takes care of small discrepancies in the alignment of the engine and generator shafts and allows each shaft to run true in its own bearings and also permits of a slight degree of longitudinal play for each shaft, which is very desirable.

A special feature of this engine is the automatic compressed-air starting device. This consists of a chain-driven valve which provides a passage for the compressed air into the three cylinders in proper sequence in whatever position the engine may be previous to starting. The air is furnished by a small compressor attached to the rear cylinder and operated directly from an eccentric on the main shaft of the engine. This compressor automatically maintains a constant pressure of 175 lb. per sq.in. on the air-storage tank back of the engine.

ELECTRICAL MACHINERY—The generator used is a 40-kw. Westinghouse multipolar direct-current machine supplying current at 125 volts when operating at its normal speed of 340 r.p.m. The current is delivered to two Westinghouse direct-current motors of 25-hp. rating, and each motor is connected to the two axles of its truck through a chain belt and speed-reducing gears operating in an air-tight, oil filled gear case.

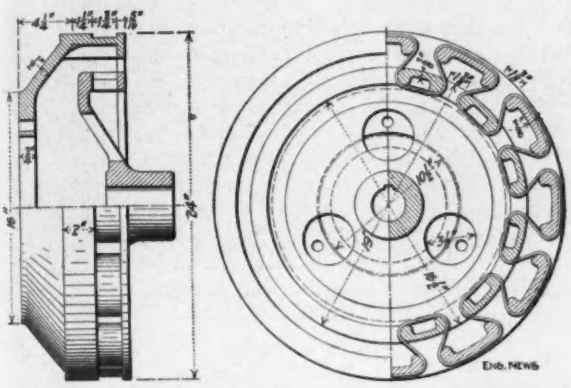


FIG. 3. FLEXIBLE COUPLING BETWEEN OIL ENGINE AND GENERATOR

AUXILIARY EQUIPMENT—A switchboard is provided directly in front of the engine and on it are placed the usual meter and switch arrangements for taking readings of current and voltage on the electrical units.

The controller furnished is of a special series-parallel reversing type in which series-parallel contacts are made on an auxiliary drum. This arrangement allows the motors to be put directly across the line in either series or parallel relation without the use of external resistance, and it provides for nine speeds forward and reverse, allowing of starting, stopping and reversing at will.

The brakes were especially designed for this service and are of the hand-operated post type, in which contracting brake blocks are applied to the outer periphery of 10-in. brake wheels, one on each motor shaft. These blocks are lined with special mineral-tanned leather designed to resist high temperatures successfully.

Dust-proof roller bearings are used for the axles and these proved to be so nearly frictionless that the completed car weighing 22 tons can be easily pushed along a level track by one man, before the chain-drive belts are attached.

Three metal storage tanks 8 ft. 6 in. long and 15 in. in diameter, are placed under the locomotive frame. About twice as much of jacket water as of fuel oil is required in a given time by this engine, so two of these tanks contain water and the other oil. The capacity of each tank is about 78 gal., a supply sufficient for more than ten hours operation at full power.

OPERATING CHARACTERISTICS

One of the objects in choosing the system above described was to obtain an engine which could run at a constant speed for maximum efficiency, the desired variation of speed of the car being obtained solely through the controller. This constant speed operation of the engine is obtained by means of a throttling governor, and tests of the entire unit showed a drop from 125 volts at no load to 115 volts at full load, or 8 per cent., which represents the speed regulation of the engine.

The special advantages obtained by the use of the chain belt and gear drive from the motors to the axles are as follows: (1) It allows the use of a short truck with only 34 in. between wheel centers, so that the locomotive can operate on very sharp curves; (2) it keeps the motors above the locomotive floor where they are readily accessible for inspection and repairs and are protected to a large extent from moisture and dust; (3) it permits a rotating speed reduction from motor to axle of four to one, giving the desired low operating speed to the car (8 mi. per hr. maximum) with use of a standard type of motor; and (4) it provides a positive drive for each axle so that every wheel is a drive wheel and so that the entire weight of the locomotive is rendered available for tractive effort.

Allowing a value of 0.2 as the coefficient of friction between wheels and rails, since the whole weight of the locomotive is available for traction, the maximum tractive effort before the wheels slip is 22 tons $\times$ 0.2 or 4.4 tons. At 8 mi. per hr. (the maximum operating speed) assuming that 50 hp. is applied to the axles, since the engine and generator have ample capacity to drive the motors up to their full rating, the tractive effort is about 2300 lb.

The Planning of a Residence District has been made the subject of a competition by the City Club of Chicago, which has offered $600 in prizes for the best plans. The assumed site is a level quarter-section of land (2640 ft. square), about eight miles from the center of the city, having no trees or buildings, and not subdivided. It is surrounded by the straight streets of property subdivided in the usual rectangular or gridiron plan, and has street-car lines on three sides. The purpose is to show the best methods of subdivision, the best disposition of space for parks and recreation centers, the best width and arrangement of roads, the most convenient location of stores and public or semi-public buildings and grounds, the most desirable provisions for house yards and gardens, and the proper density of population to be provided for. Each competitor will submit a plan and a bird's-eye perspective view. With these there must be a statement as to the number and sizes of lots, the number of families, the length of sewers, the area of street and sidewalk paving, and the percentages of total area occupied by streets and by public spaces. The arrangements for the competition are in the hands of George E. Hooker, civic secretary, City Club, Chicago.

Selling Water by Current Meter Measurement

By J. C. Allison*

SYNOPSIS—The measurement of water used for irrigation purposes by some means which shall be accurate, practicable and economically feasible has long been a problem. The difficulties of this problem were increased in the Imperial Valley, California, by the large volume of silt carried by the water, while at the same time the necessity for accurate measurement was increased by the value of water in that marvelous valley, where irrigation is practiced every month in the year. This article outlines the irrigation system of the California Development Co., tells about the Mutual Water Cos., relates the silt and other difficulties and finally describes the use of current meters for water measurements and the current-meter rating flume of the company at Calexico.

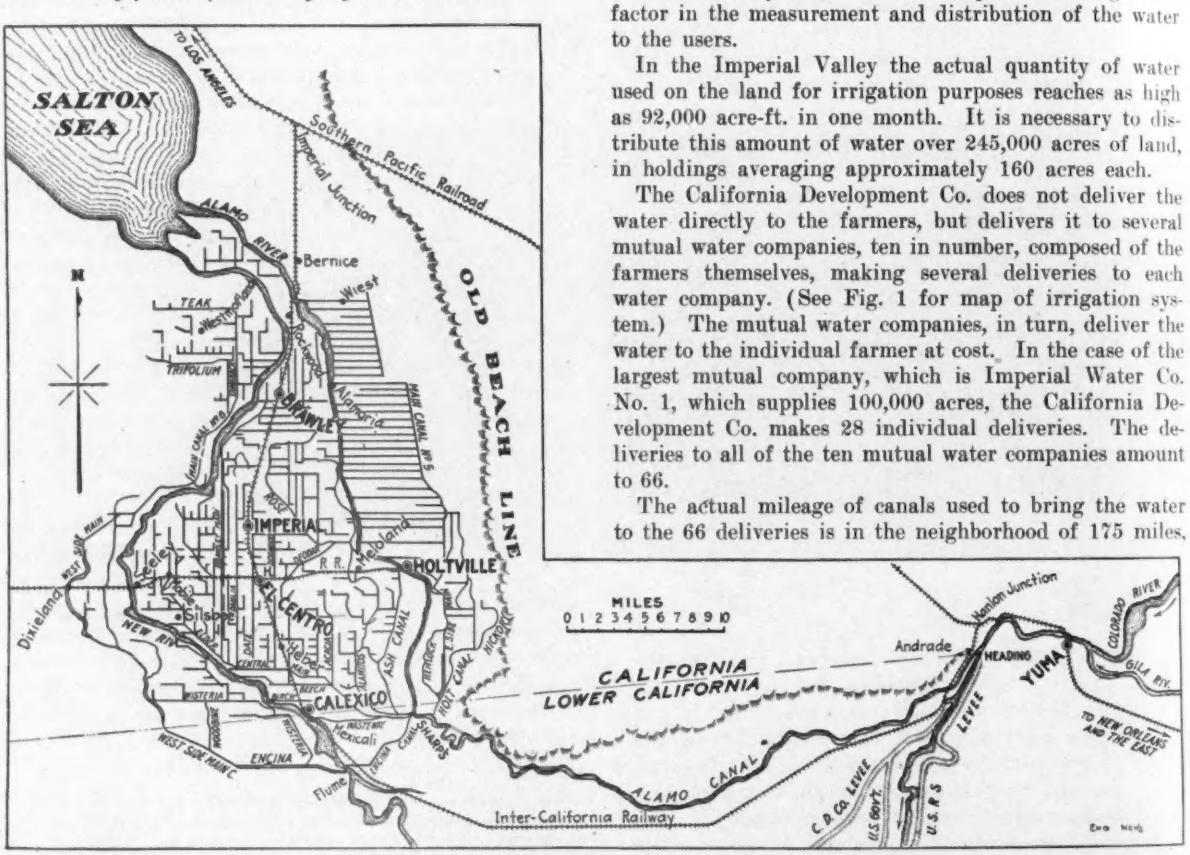


Fig. 1. Map of the Irrigation System of the California Development Co., Imperial Valley, California

Irrigation managers and engineers are realizing more and more fully the necessity of strict accounting for water, not only to promote its conservation and to insure its use with the greatest benefit, but also to make a profit. Many private irrigation projects have failed simply on account of inaccurate and wasteful methods in selling and delivering water, their chief source of revenue.

The accurate measurement of water in general is no small problem, inasmuch as the weir and orifice formulas now in general use in engineering practice are not absolutely accurate, and are not accurate at all unless used under conditions similar to those on which the equations were derived. When there is added to this the silt problem, the successful use of structures as measuring devices for the distribution of large quantities of water becomes impossible.

The Colorado River, from which Imperial Valley derives its water-supply by means of the California Development Co., carries as high as 2% by volume of suspended matter. By the time the water reaches the farmers' deliveries in the Valley, the water still carries in suspension in the neighborhood of 1 to 1½% of silt. Not only is this silt problem the greatest item in the maintenance of the system, but it also crops out as the greatest factor in the measurement and distribution of the water to the users.

In the Imperial Valley the actual quantity of water used on the land for irrigation purposes reaches as high as 92,000 acre-ft. in one month. It is necessary to distribute this amount of water over 245,000 acres of land, in holdings averaging approximately 160 acres each.

The California Development Co. does not deliver the water directly to the farmers, but delivers it to several mutual water companies, ten in number, composed of the farmers themselves, making several deliveries to each water company. (See Fig. 1 for map of irrigation system.) The mutual water companies, in turn, deliver the water to the individual farmer at cost. In the case of the largest mutual company, which is Imperial Water Co. No. 1, which supplies 100,000 acres, the California Development Co. makes 28 individual deliveries. The deliveries to all of the ten mutual water companies amount to 66.

The actual mileage of canals used to bring the water to the 66 deliveries is in the neighborhood of 175 miles, and the various distributing systems from these deliveries aggregate approximately 750 miles of canals. This latter figure does not include the mileage of head ditches and drainage ditches which the farmers own and utilize for the irrigation of their individual farms.

The irrigation season in the Imperial Valley includes the whole twelve months of the year, so that the canals are never dry. Instead of receiving their water according to schedule, the farmers are accustomed to receiving it on application after 24 hours notice. To give this kind of service in a satisfactory way, and still conserve the supply of water so as to prevent its waste, accurate measurement

*Assistant General Manager and Chief Engineer California Development Co., Calexico, Calif.

from point to point is absolutely necessary. Where the whole operation of the system depends upon the revenues derived from the sale of the water, accurate accounting for the water is also absolutely necessary.

The weir and orifice coefficient which has been arrived at by hydraulic engineers, and the resulting formula in general use for the measurement of water through openings and over weirs, require that the design of the structure, and the conditions under which the water is measured through the structure, be definitely known. It has been found here to be absolutely impossible to hold to any such formula for any individual structure, even those built originally in strict conformity with the design necessary for the proper application of the formula. This condition is due to the continual change in the condition of the channel directly above and below the structure, due to the silt deposits. For instance, the proper application of any of the weir formulas demands a lower contraction, or lip, for the water to fall over. The formulas also demand that there be a free access of air underneath the overpour. These two things in themselves are impossible, since the lip, and the consequent quieting of the water above the structure, affords an excellent berth for the deposition of silt. In the smaller structures, especially, we soon have the bottom grade of the channel on the upstream side of the structure at the same elevation as the top of the lip, hence, not only doing away with the lower contraction of the structure, but also destroying the bottom grade and carrying capacity of the canal above.

FIG. 2. VIEW SHOWING DEPOSIT OF SILT ABOVE SMALL STRUCTURE IN THE IMPERIAL VALLEY IRRIGATION SYSTEM

In building the irrigation system of Imperial Valley, the structures were built principally of wood, and very little attention, if any, was paid to the part these structures would have to play in the accurate measurement of water through them. In the case of the weirs that were constructed with the necessary contraction, it was found that the silt accumulated above them to such an extent that it did away with the lower lip of the weir by lodging against it, causing the filling up of the canal behind it. The lower contraction, therefore, became a menace, and the weir was soon abandoned and an undershot opening substituted where possible. From this on, the structures were all built with a view to cheap maintenance, but the formula was still retained for the measurement of water.

As is well known to the readers of the ENGINEERING NEWS, the Imperial Valley in 1905, 1906 and 1907, passed through a series of unfortunate experiences, due to the incomplete control of the heading at the intake on the Colorado River, through which the river broke. This was stopped by the Southern Pacific Co., after which time the affairs of the California Development Co. passed into the hands of H. T. Cory, as general manager, and F. C. Herrmann as chief engineer. The revenues from water delivered did not meet the current expenses, consequently these gentlemen soon recognized the inefficient method of measuring and distributing water as one of the many necessary subjects for improvement. As a remedy they started to calibrate each of the large structures with current meters. From the calibrations a set of tables was made for each opening in each gate.

On Dec. 13, 1909, the California Development Co. was placed in the hands of W. H. Holabird, as receiver, and the bankrupt system became dependent upon the revenues from the sale of water alone. It became more necessary than ever to account for each acre-foot of water sold and delivered to the farmers.

In correcting the method of measurement of the water to the farmers, it was first determined that the calibration tables previously proposed would not serve for the same openings for any length of time, since the continual shifting of the silt deposits above and below the openings changed the conditions entirely under which the openings had been calibrated. This is illustrated by Fig. 2, which is reproduced from a photograph taken from a point above one of the small structures with the water out of the ditch. When this opening was calibrated the canal was clear above, with no obstruction in the flow of the water delivered through the gate.

It was next determined that there was no practical solution of the drift problem as related to the large structures. In spite of the care with which the drift was removed, there were always likely to be sticks half submerged, located in the bottom or on the sides of the submerged opening, which could not be detected on account of the muddy condition of the water. This accumulation of drift would either decrease the size of the opening which the position of the gate indicated, or else it would lodge in the bottom so as to prevent the proper setting of the gate below, thus causing the appearance of a smaller opening than actually existed.

After months of experimenting it was finally decided that current meters would have to be resorted to entirely, if a proper measurement of water was to be had.

In coming to this decision due consideration was given to the extraordinary expense, in a project of this magnitude, of establishing a system wherein the daily use of current meters on each delivery became necessary. It necessitated the employment of hydrographers with considerable engineering training, in the place of the usual "zanjeros" or water tenders, and this called for the payment of larger salaries. It became necessary that a considerable amount of money be invested in current meters, since the main measuring stations necessary for the distribution of the water numbered 66, requiring some 25 or 30 separate meters, on account of the long distance between stations. With the current meter there was necessary the extra equipment of first-class stop watches, etc. Metering bridges had to be installed at stations where the canals were of uniform section, and metering flumes where the canal bottoms were irregular.

A larger force of hydrographers was needed than "zanjeros," who had previously been employed, since

less ground could be covered in one day by hydrographers than was originally covered by the "zanjeros," owing to the extra time needed to make the meter measurements with the instruments. Water-level gages had to be established in a great many instances, so as to register the fluctuations in a rating station, or the rating flumes, from hour to hour.

A rating station was established at the California Development Co. headquarters in Calexico, for rating cur-

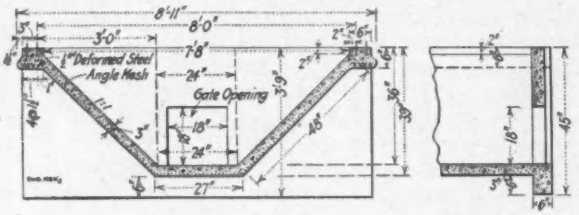


FIG. 3. RATING FLUME FOR CURRENT METERS, CALIFORNIA DEVELOPMENT CO., CALEXICO, CALIF.

rent meters, at a cost of $1360. Briefly described, the rating station consists of a reinforced-concrete flume 170 ft. in length and 3 ft. in depth, both inside measurements. The section of this flume differs from the section of the flume used by the U. S. Reclamation Service, or by the U. S. Bureau of Standards, or by the Canadian Government, as installed under the direction of the Irrigation Office in the vicinity of Galgary, Alberta. All of these flumes were built with a rectangular section. In the case of the Canadian station the tank was 6 ft. wide, and 5½ ft. deep, a section this large being used to eliminate any following movement of the water in running the meter through the tank. The same result was attained at the Calexico Station, with less expense, by using a section in the form of a trapezoid, the bottom width being 24 in., the top width 7 ft. 0.08 in., and the side slopes 1 to 1 (see Fig. 3).

In experimenting with a smaller station, previously installed, it was found that one of the main causes of error in rating meters was due to the fact that in cases where the meter was pulled through the water by hand, the speed at which the instrument was drawn, in rating for any particular velocity, was so variable, even with the greatest of care by the operator drawing the meter, that the object of determining the number of revolutions in a specified time for a certain velocity was defeated. In the final platting of the curve from which to calculate the meter equation, the points for different velocities were so variable in position that it was difficult to establish a true line through them.

At the new station, therefore, a motor car (Fig. 4) was designed, thus eliminating the main personal equation in rating meters. As yet the two additional personal equations, namely, that of recording the time and the revolutions of the meter, are still contended with, inasmuch as we have not established the automatic method used in some of the other stations for recording time and revolutions. These two factors, however, do not seem to hinder the correct rating, provided the operator uses due diligence in counting and checking the revolutions and in counting the time with the stop watch, within the known distance in which the meter is drawn. As an aid in making this record, however, an automatic marker is used at either end of the flume, so as to be able to confine the record of time and revolutions in a definitely known distance.

A Price electric meter is employed uniformly on the system, the rod being used at stations where the depth and velocities are small, the cable attachment where the depth and velocities are excessive.

On account of the silt in the water the wearing parts of the meter need more attention than is the case where the meters are used in clear water, and for the same reason the instruments are also rated more frequently. In the organization perfected it is the duty of the watermaster, through his assistants, to re-rate each meter at least once every month, and oftener where the meter is used under unfavorable conditions. After the meter is rated at the headquarters station, the curve is platted, the equation calculated, and a revised table prepared for the use of the hydrographer using the meter.

In spite of the extra expense incurred in the establishment of the plant, the saving in revenues instituted thereby and the perfecting of the distribution of the water more than warrants the change.

The results for eleven months ending May 31, 1912, as compared with the same period of time ending May 31, 1911, is best shown by the auditor's statement. The total cost of distributing the water during the eleven months ending May 31, 1911, amounted to $16,930. This expense included the watermaster, superintendents and zanjeros salaries, repairs to telephone lines, and in fact all expenses which are chargeable to the operation accounts which come under the classification "Distribution of Water."

Assuming that the conditions would have remained the same, that is, if we had continued the use of the weir measurement only, the expense of the eleven months ending May 31, 1912, would have been practically the same as for the preceding period. However, our records show that the total expense for distributing water during the eleven months ending May 31, 1912, aggregated $21,353. The increase in expense, amounting to approximately

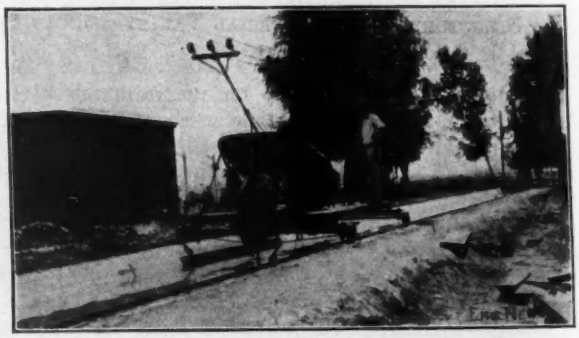


FIG. 4. RATING CURRENT METERS FROM MOTOR CAR, AT CALEXICO, CALIF.

$4400, was therefore due to the changes in the measurement of water from the weir method to the meter method.

During the eleven months ending May 31, 1912, the difference between the current meter and the headgate measurements made a net increase in revenue, due to the meter measurement, of $14,700. Deducting from this amount the increase in expense of $4400, leaves a net revenue in favor of the meter measurement of approximately $10,300.

The greatest of all among the problems to be solved was the difficulty in bringing about the change in measurement of water to the satisfaction of the farmers, since the new method of measurement would entirely revolutionize the method which had been employed for over eight years. In spite of all this evidence of extra expense and extra trouble, meaning, perhaps, extended lawsuits with the mutual companies, Receiver Holabird backed the judgment of his engineers with his necessary support, and after due notice to all of the companies the meter measurements were put into effect July 1, 1911.

At first the water companies all rebelled, as was natural, since the meter exposed the errors in the measurement through the structures due to leaks, faulty use of formulas, etc., thereby giving less water to the company and the individual farmer on the same order, than had previously been given. In other words, in place of delivering 10 cu.ft. per sec. of water, on an order for 7 ft., the meters checked the errors involved and measured to the company or farmer the exact quantity of water delivered.

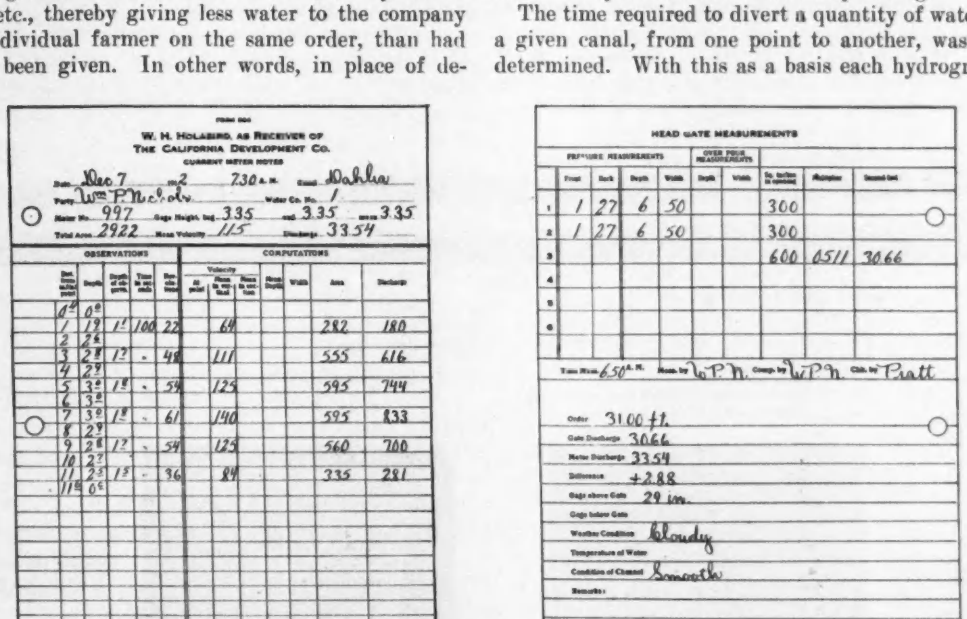
However, after several months of experimenting and checking, by the various engineers acting as superintendents of the mutual water companies, our methods were finally conceded to be as nearly accurate as is possible to attain in the distribution of large quantities of water, and the justice of the meter system was finally conceded. In the case of the largest water company, that is, Imperial Water Co. No. 1, R. S. Carberry, superintendent, went to the trouble and expense of installing an adjustable Cippoletti weir, adjustable to such an extent that he could remove the same from the water except at times when he needed its use, thus preventing silting above the structure. At this weir he required the checking of all the meters belonging to the California Development Co. which were to be used in measuring water to Imperial Water Co. No. 1.

After a careful rating of the meters at the Calexico station, and checking them against the weir station, the results showed that all of the meters would register within 1½% of the amount which the weir would measure in a stream runing about 40 cu.ft. per sec. With this demonstration of the correctness of our methods, the water companies finally conceded to our demands.

In order to bring the accounting for the water in the watermaster's office to a point wherein practically all of the waste could be eliminated, if necessary, a system was devised which resembles, more than anything else, the system used by railroads in train dispatching.

The time required to divert a quantity of water through a given canal, from one point to another, was definitely determined. With this as a basis each hydrographer was given a definite time in the day for the turning of his water and for measuring the same. In measuring his water, he was not only required to measure it with the meter in a careful manner, but was called upon also to check his work, in a rough way, by the use of the gate measurement. Later in the day he was required to return to the station and remeasure the same, so as to have a definite record of any fluctuations which might occur. A sample sheet from the hydrographer's daily water statement, for both the gate and the meter, is here reproduced as Fig. 5.

With this definite method of keeping track of the water, the watermaster, from his desk at the Calexico headquarters, can dispatch the various heads of water needed from day to day, to fill the fluctuating orders of the water companies, without waste of water, and without danger of drought or flood to the users. It was only in this manner that a 24-hour system of continuous deliveries could



W. H. HOLABIRD, AS RECEIVER OF
THE CALIFORNIA DEVELOPMENT CO.
CURRENT METER NOTES

Date Dec 7 1912 730 a.m. Canal Dahlia
Party Wm P McCoy Water Co. No. 1
Meter No. 997 Gage Height, beg. 3.35 end 3.35 mean 3.35
Total Area 2922 Mean Velocity 1.15 Discharge 33.54

OBSERVATIONS / COMPUTATIONS

Dist. from initial point	Depth	Depth of rev. in ft.	Time in sec.	Rev.	Velocity: At point	Velocity: Mean in ft. per sec.	Velocity: Mean in cu. ft. per sec.	Mean depth	Width	Area	Discharge
1st 0ft											
1 1ft	1ft	100	22		64					282	180
2 2ft											
3 3ft	1ft	.	48		111					555	616
4 4ft											
5 5ft	1ft	.	54		125					595	744
6 6ft											
7 7ft	1ft	.	61		140					595	833
8 8ft											
9 9ft	1ft	.	54		125					560	700
10 10ft											
11 11ft	1ft	.	36		84					335	281
11st 0ft											
									TOTALS	2922	3354

No. 1st 1 Meas. Comp. by W.P.M. Clk. by Pratt

HEAD GATE MEASUREMENTS

	Pressure Measurements: Front	Back	Depth	Width	Open Flow Measurements: Depth	Width	No. inches in opening	Multiplier	Second feet
1	1	27	6	50			300		
2	1	27	6	50			300		
3							600	0.511	30.66
4									
5									
6									

Time Rec'd 6.50 A.M. Meas. by W.P.M. Comp. by W.P.M. Clk. by Pratt

Order 31.00 ft.
Gate Discharge 30.66
Meter Discharge 33.54
Difference +2.88
Gage above Gate 29 ins.
Gage below Gate
Weather Condition Cloudy
Temperature of Water
Condition of Channel Smooth
Remarks:

ALL SPACES MUST BE PROPERLY FILLED OUT.
THESE SHEETS MUST BE SENT TO CALEXICO OFFICE PROMPTLY AT THE END OF EACH WEEK.

FIG. 5. SAMPLE SHEET OF HYDROGRAPHER'S METER AND GATE MEASUREMENT OF INDIVIDUAL IRRIGATION WATER DELIVERY

be made, since the dispatching of water through 175 miles of main carrying canal requires a definite knowledge of the behavior of the water in each instance.

From the telephone communications from station to station, the watermaster is able to receive his orders from the mutual companies, instruct his hydrographers as to the carrying out of the orders, and from this make a daily report in such a complete manner as to account for practically every foot of water delivered into the headgate from the Colorado River, after the seepage and evaporation allowances have been made.

The watermaster's daily record is made up on a form sheet 11x17 in. in size. In the upper right-hand corner provision is made for recording gage heights above and below the main diversion gate and also the discharge through the gate. The body of the sheet provides for entries of the amounts of water diverted into the four main and the 18 sub-main canals; for deliveries from these canals to the various mutual companies and to each of the (about 65) canals of each of these companies; for amounts ordered for each of the smaller canals; for waste; and finally for actual and percentage losses. The lower part of the sheet gives further records for the main diversion from the river.

A majority of the irrigation projects in the Southwest have the silt problem to contend with. The experience of the California Development Co., narrated in this article, will, I trust, be of some use to the engineers of these projects, especially since the time is fast approaching when the accounting for every foot of water available in the rivers in the Southwest will become necessary. It has been principally due to the strict measurement and accounting for the water delivered to the farmers of the Imperial Valley that the California Development Co., under its receiver, has been able to deliver water at 50c. per acre-ft., with a 10% allowance for seepage and evaporation, on a 24-hours notice basis, and still operate the once bankrupt company at a profit. This is forcibly illustrated by the fact that the receiver has overcome a deficit of some $5000 per month, and is now making a net revenue in excess of $16,000 per month.

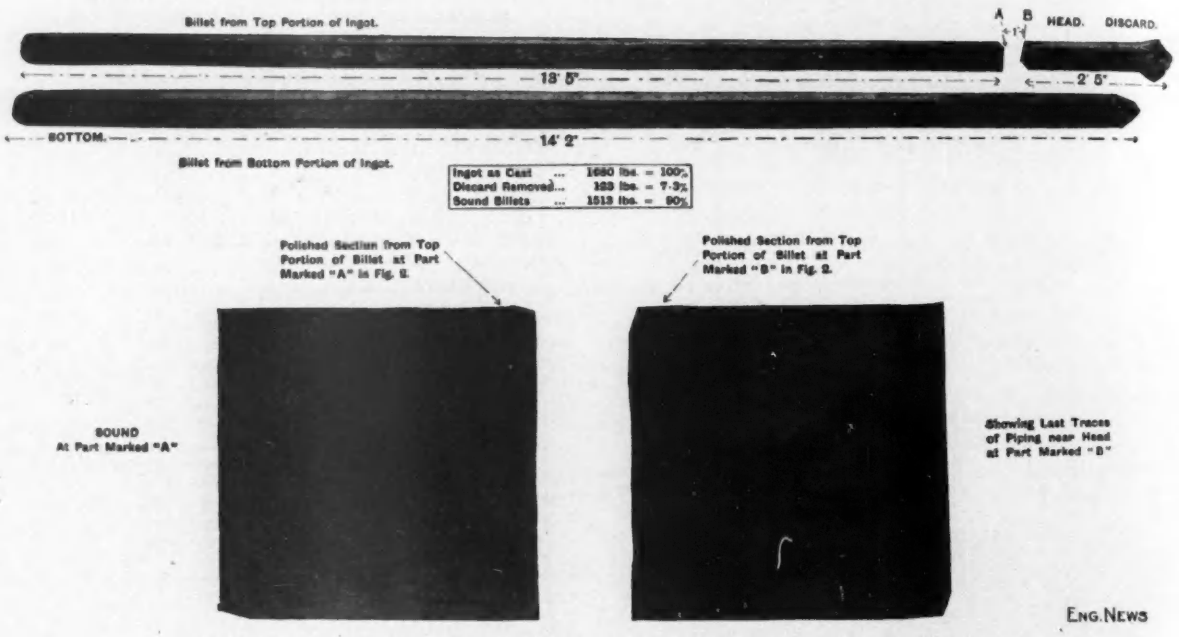
⁂

The Hadfield Top-heating Method of Eliminating Pipe in Ingots

The method of producing pipeless ingots worked out by Sir R. A. Hadfield, described in ENGINEERING NEWS, Nov. 21, 1912, p. 955, has proved highly successful, according to information received from the inventor. He states:

> We have already made 15,000 tons of ingots by this system, and to the best of my knowledge I am correct in stating that in this large lot we have not had a single waster ingot, which is a remarkable record.

As further illustration of the thorough elimination of pipes by the particular form of top-heating which he employs,* a new photograph showing the product of a Hadfield ingot of 1680 lb. is reproduced herewith. The text explanations on the picture give the data as to weight and discard. The complete disappearance of pipe 30 in. from the head of the billet is shown by the two cross-sections.


Billet from Top Portion of Ingot.
A
B
HEAD.
DISCARD.
13' 5"
2' 5"
BOTTOM.
14' 2"
Billet from Bottom Portion of Ingot.
Ingot as Cast ... 1680 lbs. = 100%
Discard Removed... 169 lbs. = 7·3%
Sound Billets ... 1513 lbs. = 90%
Polished Section from Top Portion of Billet at Part Marked "A" in Fig. 2.
Polished Section from Top Portion of Billet at Part Marked "B" in Fig. 2.
SOUND At Part Marked "A"
Showing Last Traces of Piping near Head at Part Marked "B"
ENG. NEWS

BILLETS FROM 11-IN. HADFIELD INGOT, SHOWING OVER 90% SOUND METAL

⁂

Very High Ocean Waves are reported in a recent press dispatch from Portland, Ore., which, in part, reads as follows:

> Unusual damage done by waves was reported by William Dahlgren, keeper of Trilamook Rock lighthouse, south of the Columbia River.
>
> A storm that swept the coast, Oct. 18 and 19, carried away a large portion of the west end of the rock foundation, and waves invaded the top of the tall lighthouse, putting out the lights and filling the trumpet of the fog signals with rocks. The focal plane of the light, 132 ft. above high water, was broken.
>
> The siren, which was filled with rocks, is 114 ft. above the high-water mark. None of the lighthouse employees was injured.

[We trust the refractive index is still intact.—Ed. Eng. News.]

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*Top-heating for preventing piping of the ingot is not new. Hadfield uses a sand mold for the upper part of the ingot, an insulating layer of slag on the metal, a layer of charcoal over this, and an air-blast directed down on the charcoal to burn it.

The Ethical Relation between the Draftsman and the Mechanical Engineer*

By F. R. Hutton, Sc.D.†

The engineer is dependent on the draftsman, but the latter must return to the engineer the loyalty which is his *noblesse oblige* by reason of that dependence. He must put his knowledge and skill at the service of his professional chief without mental reservations or withholding of his talents.

But here possibilities of serious trouble may arise in the relations of draftsman and engineer. I am assuming the normal case where the engineer is the older and more experienced and able man: and where by virtue of these conditions he is the employer and the draftsman is the employee.

It may easily happen, however, that the draftsman may be the abler man, and may have sounder judgment and wider experience than the engineer. Suppose in such a case the engineer makes a blunder, an error in his arithmetic, a misreading of some law of physical science; a wrong decision in balancing alternatives. What course should the subordinate draftsman take?

Plainly, he should, first, in a tactful way, call his chief's attention to the error. Not by the name of *error* or *blunder,* but by some such formula as:

"Mr. Blank, I cannot get the same result that you do for the cross-section of this member. Have I made assumptions different from yours? 'Kent's Pocket Book' gives the formula as follows," etc.

"If he will hear thee" (to use the biblical phrase) "thou hast gained thy brother." But perhaps he will *not* hear thee, and because of obstinacy or pride of position, or for graft, or under compulsion from higher authorities, he persists in the error. In such a case there are four alternative courses open to the draftsman:

(1) It may be a trifling detail, where the failure will not reflect upon your professional competency. You may possibly be wrong in your judgment, and it is not of great consequence anyway. Only money loss will be entailed by failure. If this is the case, then shrug your shoulders, reserve the right to say, "I told you so," with its great mental comfort, and go ahead.

(2) The money loss by failure will be considerable: it will be so great as to involve a reflection on your competency and your future earning capacity as a careful and experienced draftsman. Here there are the usual two alternatives. The one is to resign, stating your reasons in your letter of resignation; and "shake off the very dust from off your feet!" This should always be done if the failure due to the error will cause loss of life or injury to persons. The other alternative is to make your protest in writing, and go on with your work. A copy of the written protest may be filed with the Society of Engineers or Draftsmen under your name, to be produced only in case your reputation is involved in the failure of the structure or the dam, and so that the blame may be laid on its responsible designer. To resign, however, is usually the better course, because after such a letter of protest has passed, the bond between draftsman and engineer is so shattered that they cannot work together to advantage.

This brings me to a further problem in the relation of draftsman to engineer. Who is entitled to the credit for success in a structure or a machine: the man who had only a general oversight and control while the draftsman furnished all the details which enable success to be attained; or may the draftsman claim the credit for himself?

The shortest answer is that he who must take the blame for errors and failure is entitled to the credit for success. Usually when the final drawings are signed by the highest authority in matters of design, such a signature entitles the signer to responsibility in both directions. If there was something wrong, he made it his by signing; if it was something fine and original, he made it his by that signature. Responsibility never ceases till it reaches the top. With the professional right to alter or change or veto the drawings goes the right to credit or to blame. If the draftsman signs drawings without professional revision from above, he is the engineer, whatever his title.

Finally, what are the relations of the draftsman to his engineer as respects a proprietary right in the design and drawings which he creates as the craftsman for the engineer? It is the same I think as the relation of the engineer to the corporation for which he labors; it is the same as their relations respecting patents or inventions which originate in their work.

The matter may appear in a wide range of variants:

(1) May the draftsman take blueprints from his drawings or those of his colleagues working with him, and carry these away as his own property, when he leaves that employing engineer or corporation? These are, perhaps, memoranda of his own computations; they will enhance his value to any engineer working with him, because they embody successful solutions of past problems. Are such blueprints his?

(2) Suppose he bought his own print-paper and did the printing at home on Sundays or in over-time, so that the employer could not claim that because they were done in time for which *he* paid therefore they could not be claimed by the draftsman.

(3) Suppose that instead of being embodied in drawings, this same information, tables of sizes and proportions, design data and standards were in note-books; may the draftsman copy these and carry such priceless information with him to his next place, perhaps to a rival competitive concern?

(4) Can an improvement in a process, or a new process or an improved design or new mechanical motion be patented by the draftsman who is working on the problems of the engineer and be used to hold up his employer until the parties can agree as to terms of use or sale?

The accepted answer, emphasized by decisions of courts and embodied in standards of professional ethics is that as between engineer and draftsman such patents, notes and drawings belong to the engineer; and as between engineer and an employing corporation or firm or individual, they belong to the *employer,* and are not to be taken away with the employee.

The reasons back of this practice include the following:

(1) The shop furnished the plant—rent, heat, light and tools—where these ideas were conceived.

(2) The shop presented the problem. Without these

*Extract from an address before the American Society of Engineer Draftsmen, Dec. 19, 1912.

†Consulting engineer, 257 West 86th St., New York City.

the invention or design would never have been created.

(3) The shop furnished antecedent knowledge and acquired experience which molded the creation.

(4) The shop furnished experimentation, actual or precedent, which gave the creation its practical or commercial shape.

(5) For many creations the shop furnished or will furnish manufacturing facilities which the inventor would have to struggle to obtain elsewhere.

(6) For many creations, the shop furnishes the selling or marketing facilities of its commercial organization.

If, however, the invention is entirely outside the employer's business, this principle does not apply; or if it is one he cannot use, then the inventor or designer is like any outside person. Or, the draftsman or engineer may contract to give shop or manufacturing rights to the employing shop while retaining the right to sell or license to outside parties interested.

Closely interwoven with this is the "trade secret" question, where the employer confides knowledge of immense commercial importance to his engineer and draftsman. In European practice, which has also some vogue in America, the engineer and draftsman agree by signed instrument not to enter another concern in the same line of production for five years after leaving his confidential relation. Five years will render much of the knowledge obsolete, or the first concern will not suffer much from the chase of another five years behind it.

And this brings me finally to the conclusion of the whole matter. The relation of the engineer and draftsman is a reciprocal one, and may be summed up in the epigram which we call "The Golden Rule": "Do unto the engineer as ye would that the engineer should do unto you"; or "Put yourself in his place," and do as you would that your draftsman should do to you. Nothing is more traitorous than to receive money from a competitor as the price of betraying to him the brains of your engineer.

Grade Reduction on Street Railways

By Carl H. Reeves*

SYNOPSIS—The growth of the business section of the city of Seattle, Wash., was hampered by the existence of high and steep hills which gave very unfavorable grades for streets. In view of the rapid growth and great commercial development of the city, the authorities adopted the radical process of removing the higher parts of the hills and using the material to fill in the valleys, thus entirely changing the topography of certain sections of the city.. The excavation was done in part by machinery and in part by hydraulic grading, as has been described in Engineering News. *As several of the streets affected were occupied by street-car lines (electric and cable) the street railway company had to undertake the lowering of its tracks to the new grades and at the same time to continue to handle its traffic. This difficult and very interesting work is described in detail in the accompanying article, prepared for us by the engineer who was in direct charge of the work. Similar reduction in grades and summit elevations has been undertaken in Portland, Ore., and Pittsburgh, Penn., but the city of Seattle was the pioneer in work of this kind.*

In order to meet the needs of a rapidly growing city, in regard to reasonable grades for street traffic in the central business district, the engineering department of the city of Seattle has had some gigantic engineering problems to meet, in modifying the topographic conditions. It need only be stated here that these were met and solved under the leadership of R. H. Thomson, then City Engineer, in a very creditable manner and to the satisfaction of the citizens of this city. In this extensive grade reduction work,† property owners were put to great expense in meeting the changed conditions due to radical changes in street grades, but it is a fact of record that this great change was made upon majority petition of the property owners immediately interested.

The Puget Sound Traction, Light & Power Co. operated a street-railway system in Seattle by virtue of franchises granted it by the City Council, and these franchises require the company to care for its portion of the streets as follows:

"Whenever and to whatever extent the grade of any of the streets over which the lines of said tracks shall extend, shall be changed by said city, said track shall be so adjusted and changed as to conform to said grade so established, said adjustment and change in all things to be made at the cost and expense of the owner or owners of said track."

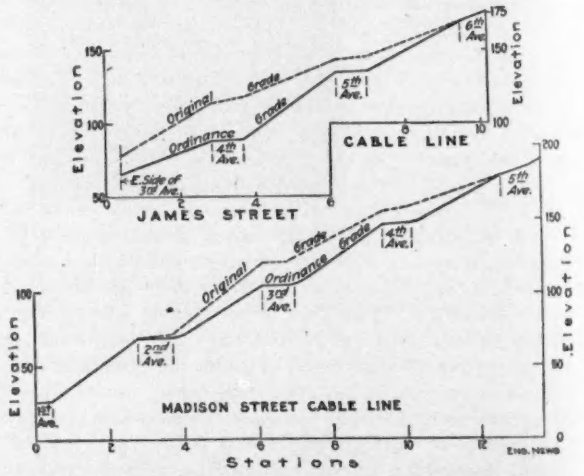

Fig. 1. Profiles of the Old and New Grades of the Cable Railway Lines on James St. and Madison St., Seattle, Wash.
(These two lines are parallel and about four blocks apart).

The company has had some extremely difficult prob-

*Field Engineer, Puget Sound Traction, Light & Power Co., Seattle, Wash.

†Engineering News, Nov. 12, 1908, and Mar. 31, 1910.

lems to solve in connection with the regrades to be considered in this article. Aside from the cost, which was by no means small, the problem of maintaining service for the accommodation of the traveling public required very careful planning and detailed execution. The lines affected by regrading operations were the following: A, the Virginia St. line in the Denny Hill regrade district; B, the 3d Ave. line, the Yesler Way, James St. and Madison St. cable lines in the combined 3d, 4th and 5th Ave. districts; C, the Jackson St., and South Seattle lines in the Jackson St. district; D, the Main St. line and Madison St. cable line in the 12th Ave. district; E, the track embraced in the Pine St., district; and F, the Eastlake line in the Howell St. district.

The Virgina St., 3d Ave., and Main St. lines being electrically operated, and having adjacent streets with trackage facilities unaffected by the regrading, were abandoned temporarily and the traffic was handled over other lines. This arrangement, however, could not be made in the case of the Jackson St., South Seattle, and Eastlake lines passing through the Pine St. and Howell St. regrade districts, nor on the cable lines.

When the work in the Jackson St. district progressed to a point where operation on the existing tracks was a hindrance to the contractor on the work, the company secured temporary permits from the city for relocations during the further progress of the regrade. In addition to removing the existing tracks on Jackson St. between 6th Ave. South and 12th Ave. South, and 4th Ave. South and Seattle Boulevard between Jackson and Plummer Sts., the company was obliged to build 4200 lin.ft. of double track to carry the traffic around this work. Similar conditions existed on the Eastlake line, where 1200 lin.ft. of double track was constructed in a temporary location. Other tracks in the Pine St. regrade district, being merely transfer storage tracks, were abandoned during the filling.

Owing to the fact that the 12th Ave. regrade project was coincident with the company's electrification of its Madison St. cable line between Broadway and 21st Ave., it was possible to transfer traffic from one street to another so as to accommodate the contractor as well as the public. In this district East Pike St. was the first to be filled. Tracks were laid on this fill, and those on East Pine St., one block to the north, were removed. East Pine St. was then filled, East Madison St. being the last street occupied by a street railway to be brought to the new grade. This having been done all tracks were replaced and traffic resumed as before.

The problem of caring for traffic on the cable lines affected by the various regrades was really the most complicated portion of these undertakings. This article will therefore deal principally with this phase of the work. The 3d Ave. regrade contract, which was the first to affect our cable lines, was let Aug. 8, 1905, and reported completed June 28, 1907. This required the readjustment of all cable lines for two blocks, one block on each side of 3d Ave. The work was started at Yesler Way (occupied by a cable line) and proceeded northerly, crossing the cable lines on James St. and Madison St. The cut at Yesler Way and 3d Ave. approximated 5 ft., that at James St., 13 ft., and that at Madison St., 16 ft. Fig. 1 shows the old and new profiles of the James St. and Madison St. cable lines, these streets being parallel and four blocks apart. The Yesler Way cable line was the easiest to handle. The 4th and 5th Ave. regrades caused considerable work on this line but very little change in grade was required, as both of these streets go under Yesler Way, which necessitated the construcion of viaducts. The profiles in Fig. 2 show the old and new grades of the Virginia St. electric line which was abandoned during the Denny Hill regrade work. The maximum cut on this line was about 108 ft., at the intersection of Blanchard St. and 4th Ave. On the Jackson St. line the maximum

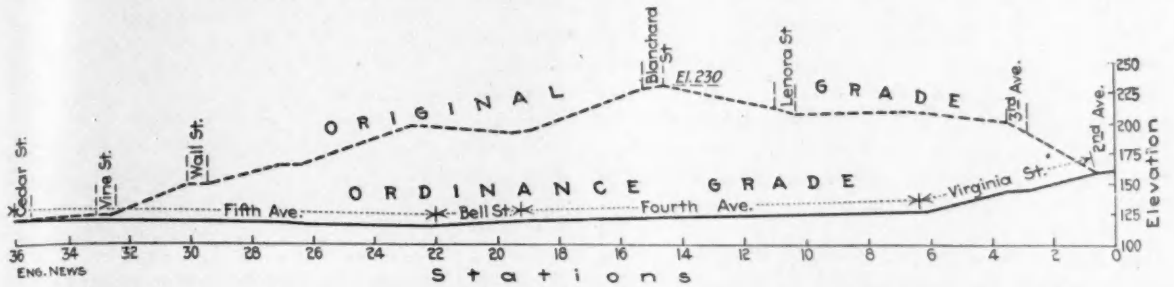

FIG. 2. PROFILE OF THE OLD AND NEW GRADES OF THE VIRGINIA ST. ELECTRIC RAILWAY LINE, SEATTLE, WASH.

FIG. 3. LOWERING THE JAMES ST. CABLE LINE, SEATTLE, WASH.

(The top of the grade in the foreground is at the intersection of Third Ave. The left-hand track is at the new grade. The right-hand track has to be lowered 10 ft.)

cut was approximately 90 ft., with fills on Seattle Boulevard of 27 ft. and under.* The 3d, 4th, 5th and 12th Ave. regrades were steam-shovel projects. The Jackson St. and others were done by hydraulic grading and the Denny Hill regrade was a combined hydraulic and steam-shovel project. Under the terms of the street railway company's franchises the following quantities of earth were paid for by the company:

	Cu.yd.
Virginia St.	140,810
Jackson St.	96,650
Pine St.	30,485
Third St.	22,285
Twelfth St.	13,501
Fourth St.	9,515
Fifth St.	2,058
Total	317,304

Changing Grades on the James St. and Madison St. Cable Lines

The cable lines were all carried on cribbing during the regrading work, as shown by the accompanying views. The profiles in Fig. 1 show the changes of grade on two parallel stretches of the James St. and Madison St. lines, which lines are four blocks apart. Prior to the regrade

Fig. 4. James St. Cable Line Supported on Cribs across 3d Ave. during the Excavation for Regrading

work on 3d Ave., the James St. line operated over a grade of 18.5%, a temporary grade of 19% having been maintained between 3d and 4th Aves. during the progress of the work. Fig. 3 shows the manner of handling the tracks on James St., and gives a fair idea of the method of cribbing used. It shows the north (left) track at 3d Ave. lowered practically to the new grade, with the south (right) track on the cribbing still to be lowered about 10 ft.

This lowering was done in stages after the close of service each night and before operation was resumed the following morning. A lowering of 5 ft. in a track during one shift of about four hours was the best record made. Beveled shims were placed under the shoulders of the yokes to maintain the grade in all positions. Fig. 4 is looking south on 3d Ave., showing a view of the cable tracks at James St., and the regrade work in progress between Jefferson and James Sts.

*The profile of this line, with the new and old grades, was shown in our issue of Nov. 12, 1908.—Editor.

The most difficult piece of cable track to handle during this regrade was on Madison St., with a cut of 16 ft. at 3d Ave. (Fig. 1). Six nights were required to bring these tracks to grade at that point. The men on the day shifts handled all ditching, secondary cribbing, and placing of timber for the night crews. Prior to the regrade, Madison St. cable line was operating over a 20.4% grade between Second and Third Aves. It is now a grade of 16.7%. A temporary grade of 19.9% was maintained during this work between 3d and 4th Aves. Fig. 5 shows the regrading work in progress at the intersection of Madison St. and 3d Ave. The men at the left are standing at approximately the new grade. The tracks are on cribbing, ready to be lowered, the ends of the cable yokes resting on the top timbers.

The regrade on 3d Ave. reduced an 8% grade from 2d Ave. to the alley east of 3d Ave. to 4%, and increased it to a permanent 10% grade east of that point. The 3d Ave. regrade was followed very shortly by the 4th Ave. regrade, and the latter by the 5th Ave. regrade. This removed the temporary grades previously mentioned between 3d and 4th Aves. on James and Madison Sts. The

Fig. 5. Lowering the Madison St. Cable Line, Seattle, Wash.

(The car is standing just beyond the intersection of Third Ave. The street has been excavated, and the tracks are supported on cribs built on the new grade line and are ready to be lowered.)

Madison St. line at 4th Ave. was readily handled, as the cut was but 9 ft. This placed Madison St. on its permanent grade between 2d and 5th Aves., which is shown in Fig. 1.

The conditions at James St. were much more complicated. With a cut of 27 ft. it was impossible to handle this track at the intersection of 4th Ave. as it had been previously handled at 3d Ave. Cribbing was used between 3d and 5th Aves. with the exception of the intersection of 4th Ave., where frame bents were sunk to the finished grade, allowing the 4th Ave. tracks to be operated beneath those of James St., as shown in Fig. 6. This view, however, shows the structure after the earth was removed by the steam shovel, which is seen working in the background. Owing to the great distance that it was necessary to lower these cable tracks, it was not considered safe to proceed as in the former cases, so a permit was secured from the Department of Public Utilities to close this line during the process of lowering. This was possible on the James St. cable, owing to the fact that the

line is but 3700 ft. long and connects with a distributing point at its outer terminus. The distributing point was moved four blocks to the north, connecting with the Madison St. cable line at that point so as to accommodate the public.

FIG. 6. THE JAMES ST. CABLE LINE SUPPORTED BY TRESTLE BENTS (INSTEAD OF CRIBBING) AT 4TH AVE. TO PERMIT OF TRAFFIC OPERATION ON THE 4TH AVE. LINE

(The track on the trestle is at the original grade and is to be lowered to the grade of the track beneath. The building marked A is shown also in Fig. 8, which is a view of another stage of work in the same place.)

A 15-day shutdown was necessary to bring these tracks to the permanent grade. They were lowered as shown in Fig. 8. Here the right-hand track and one section of the left-hand track have been lowered, and the men on the cribs are lowering the adjacent section. The frame bents at 4th Ave. were removed and replaced with cribbing and then the tracks were cut, and lowered in sections.

When this work was completed a temporary grade was maintained at 20% and 21% up to 5th Ave. This has since been placed on a permanent grade in connection with the regrading of 5th Ave.

METHODS OF PROCEDURE

The organization on the work was composed of a day crew and a night crew; each consisted of one bridge foreman, one sub-foreman with 12 men and one track foreman with 15 men. These crews were duplicated for night work. All of the work was done by company force, except the removal of the earth after it had been thrown from our right-of-way by our men. The hauling away was done under contract with the contractor at work on the street.

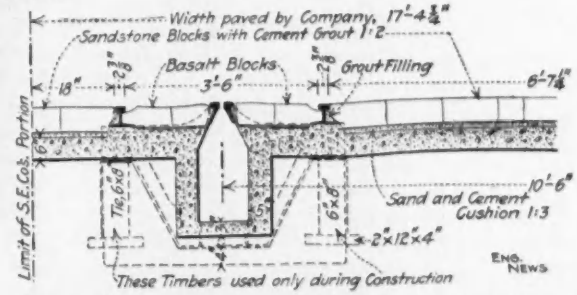

FIG. 7. HALF CROSS-SECTION OF THE CABLE-RAILWAY CONSTRUCTION ON JAMES ST., SEATTLE, WASH.

(This shows the yokes and concrete of the conduit, and also the paving in the width of street, which the railway company is required to pave.)

The cable line construction was all on cast-iron or built-up yokes, spaced in most cases 5 ft. apart. Cribbing was placed under each alternate yoke, the intermediate yokes being dug out and changed, as the old yokes were rather light; and as the permanent work was to be in paved street with concrete base, heavier yokes were put in throughout the district. The digging out and placing of cribbing at alternate yokes was done largely by the day crews; they prepared everything as near as possible for the night crews to take up the work, new yokes being placed at the alternate points as before mentioned. Throughout this district, where the rail was of a light

FIG. 8. LOWERING THE JAMES ST. CABLE LINE ACROSS 4TH AVE., SEATTLE, WASH.

(Owing to the great change in grade at this point traffic was suspended and the tracks were cut, as shown at the left. The men on the cribs are lowering the last section with jacks. The Fourth Ave. tracks may be seen just beyond the spade in the middle of the view. This crossing is the same one shown in Fig. 6, and the building marked A appears in both views.)

section, new 60-lb. rail was placed before any raising or lowering was started.

We usually took from 80 to 100 ft. of single track at a stretch for one setting of the jacks, and lowered from 6 to 8 in. and in rare cases, 12 in. The question of the amount of lowering depended somewhat upon the vertical curves at the street intersections, where it was necessary at frequent intervals to cut the rail. An average of six jacks was used on each section. We had no curves to handle, other than the vertical curves mentioned, and the principal difficulty in lowering these was the possible change in shortening or lengthening of the track. The rails, joints and slot rails were in good alignment and surface after this handling, considering the work, as we renewed all the yokes and light rail before attempting any lowering. Of course these tracks were not placed to permanent line and grade until the very last thing, when we were ready to lay the concrete and put in the paving. There was no settlement of our cable tracks, for the reason that all of these were in excavated portions of the street. All of our electric tracks, as mentioned already, were removed from the regrade district. When they were replaced on fills they were not placed in paving, and in fact very little of the electric track in those filled districts mentioned has been paved even to date.

In most cases the contractors on the street removed all the earth between our tracks and the property line that it was safe to remove before we did any work on the tracks themselves. The earth was then thrown out (as previously mentioned) at the alternate yokes and pits dug in which to place the cribbing. (See Fig. 5). The procedure was then as described above. After all excavating had been completed and the tracks lowered to approximately the permanent grade, grade stakes were set for all four rails along the tracks in the portion to be paved; and on the two outside stakes line was also established one foot from the gage of the rail. Of course the tracks in this position had very little support aside from the small blocks under the shoulders of the yokes holding them in position. The tracks were then placed to line and grade and forms set for concreting. Fig. 7 shows the concrete section on these cable lines. After this concreting was completed, the paving (of whatever nature) was placed.

The only material variation from the methods described was the using of frame bents at the intersection of James St. and 4th Ave. where the cut was excessive, as mentioned already.

Traffic Operation During Changes

The average headway on the cars of our cable lines was 2½ min. on the Madison St. cable, and 3 min. on both James St. and Yesler Way, with a shortening of about a minute during the rush hours. The speed of our cables at the time of this regrade work was 11.3 m.p.h. for Madison St., 9.4 m.p.h. for James St., and 11.1 m.p.h. for Yesler Way.

The principal precautions taken to insure safe movement of cars were in the nature of keeping track-walkers or watchmen on the work. It was their special duty to keep all bolts properly tightened, and all shims and wedges in place; and in case of any irregularity which they could not care for, to get into immediate touch with the office or call upon other men working on the job to set things right. There was but one derailment during all this work; that was on Madison St., and did not result in anything serious. The only other accident that we had was caused by the breaking of a sewer at 4th Ave. and Madison St. during a heavy storm which washed out several of the crib bents. This caused a delay in the service of but a few hours until the cribbing and track were in shape again for operating.

⁂ ⁂

New Sewage Treatment and Disposal Standards

In our issue of Dec. 19, 1912 (p. 1159) we published a brief editorial summary of the Eighth Report of the Royal Commission on Sewage Disposal,* which report is devoted wholly to standards for effluents from sewage treatment works and to a standard for sewage disposal without treatment. We now abstract the report at some length, as follows. Interested readers are referred to the report itself.

First of all, the Commission proposes the repeal of the British law which for 36 years has virtually demanded that all sewage discharged into non-tidal waters must be purified to a high degree, quite regardless of all local conditions. In place of this Quixotic requirement, which was never generally enforced, but which caused the waste of millions of pounds sterling needed for other purposes—the Commission recommends standards which may be applied, modified or entirely set aside, in accordance with all the governing local conditions affecting natural drainage districts in general and individual towns or sewage disposal systems in particular.

The one inflexible thing about the standards is that the discharge of sewage into a stream shall not create a nuisance as regards "smell, over-development of gray algal growths, accumulation of putrefying sewage solids and detriment to fish life." Extended studies by members and officers of the Commission have shown that suspended solids and oxygen consumed in five days afford satisfactory chemical tests upon which to predicate the likelihood of a nuisance. Where the dilution is small, as is so frequently the case in England, both these tests are advised, but where it is relatively large, the oxygen consumed determination may be omitted and the permissible amount of solids may be increased by degrees until even the solids may be disregarded, unless local conditions demand such minor removal as can be effected by screening or detritus tanks.

The standards set up are based, first of all, upon experiments and observations which showed that when water from the dry-weather flow of a stream takes up no more than 0.4 part per 100,000 of dissolved oxygen in

*The report proper comprises less than twenty pages and is published in London at only 3d. or about 6c., by Wyman & Sons, Fetter Lane, E. C., London, England. Probably 1d. extra would be charged for postage to the United States. We are not yet able to state the price of the appendix, but it is likely to be several shillings. Those who wish to order direct can best make remittances by international money order.

five days at a temperature of 65° F.* the stream "will ordinarily be free from signs of pollution." In order to apply this limiting figure in practice it is necessary to take into account the oxygen absorbing powers of both the stream which is to receive an effluent, and the effluent itself, as well as the relative volumes of the stream and the effluent. Taking 0.4 as the limiting figure, we have:

$$\frac{x + yz}{z + 1} = 0.4$$

where x = parts of dissolved oxygen taken up per 100,000 parts of effluent; y = the same for the river above the outfall; and z = the dilution (proportion of river water to effluent).

Applying this to an effluent which absorbs 0.1 part of dissolved oxygen in five days, and is discharged into a stream having ten times the volume of the effluent, we have:

$$x + \frac{(0.1 \times 10)}{10 + 1} = 0.4$$

which becomes

$$x + 1 = 4.4$$

and $x = 3.4$ parts of dissolved oxygen.

To permit a different effluent standard for each works would result in difficult central administrative problems, an unequal distribution of burden on each community in a drainage area, and "would go further in the direction of differentiation than is necessary to insure economy." It was therefore decided to have only a few standards and to have each of those conform approximately to the "degrees of purification attainable in practice by different systems of treatment properly supervised." Three "methods of sewage treatment" arranged in ascending order of efficiency and (broadly) of cost, were chosen and standards worked out to conform to these. In addition a standard was provided for sewage discharge without treatment. The three methods were: (1) "Simple settlement or septic tank treatment," and, (2) "settlement with the aid of chemical precipitation," each of which is an "incomplete system," and (3) "complete systems, including biological treatment of the liquor in artificially constructed filters or on land."

Before corresponding standards could be formulated, it was necessary to decide what should be considered a standard diluting water. From actual studies of rivers the following gradations of river quality and of parts of per 100,000 oxygen absorbed in five days were found to correspond: Very clean, 0.1; clean, 0.2; fairly clean, 0.3; doubtful, 0.5; bad, 1.0. It was decided to take a "clean" river, or one absorbing 0.2 parts of oxygen, as a normal stream for standard framing purposes.

Taking up next a standard for towns or works where the available dilution is small, and therefore a "complete treatment" is necessary, the Commission recalls the fact that in its fifth report it insisted on the importance of limiting the suspended solids in the effluent from "complete treatment" works and laid down 3 parts of solids per 100,000 as that limit—a standard which had "been commonly attained" at "a number of places." This standard is retained. In the fifth report also a dissolved oxygen standard of 1.5 parts per 100,000 taken up in five days, was recommended, but this was after the effluent had been passed through filter paper. Later investigations having shown that here are serious "practical difficulties in the way of removing suspended solids in a uniform manner, either by filter paper or otherwise," the Commission concluded that the "dissolved oxygen absorption test should be applied to the effluent as discharged, i.e., with its suspended matters."

After taking into account results obtained in practice at various works, the Commission decided upon and recommended a dissolved oxygen standard of 2.0 parts per 100,000 which, after allowing "for the oxygen taken up by the solids, is slightly more stringent than that previously suggested by us." Quoting a bit from the report:

> An effluent, which takes up 2.0 parts of dissolved oxygen in five days, will need some dilution if nuisance is not to be caused. The minimum degree of dilution required for safety can be ascertained by applying the formula on the lines already indicated, thus:
>
> $$\frac{2 + (0.2 \times z)}{2 + 1} = 0.4, \text{ or } z = 8$$
>
> We think it may safely be assumed that the great majority of effluents are diluted by more than eight times their volume of river water.

It should be remembered that this standard of 3 parts of suspended matter and 2 parts of dissolved oxygen applies to conditions demanding sewage works for "complete treatment." It is recommended as a "normal standard," to be of general and uniform application except where a proper central authority [still to be created de novo or designated from existing government departments—Ed.] grants an application for a lower standard, on the one hand, or, on the other, sets up a "specially stringent standard" to meet exceptional conditions—chiefly very small dilutions. The Commission wisely leaves such stringent standards for determination to suit the needs of each particular case.

Under no circumstances, the Commission says with emphasis, is meeting a standard, no matter how stringent, to be *"held to justify the use for drinking purposes of streams receiving those effluents without subsequent treatment by the water-works authority."* [Italics ours. —Ed.]

Claims for "Relaxation of Normal Standards," the Commision states, may be entertained:

> (a) When it can be shown that the particular river water is of such quality and volume that when mixed with a sewage or sewage liquor of known or calculated strength and volume it does not or would not take up more than 0.4 parts per 100,000 of dissolved oxygen in five days; and
> (b) When there is reason to suppose or when it can be shown that the river will receive no further pollution until it has recovered itself so far as not to take up in five days an amount of dissolved oxygen much in excess of that which it took up before receiving the first discharge.

Since the main effect of "incomplete systems of treatment" is to reduce the suspended solids in sewage, dissolved oxygen is omitted from the "relaxed standards," leaving the diluting river water to provide this. But though dissolved oyxgen does not appear in these standards, it was used in the studies on which they are based.

Making use of the 0.4 parts per 100,000 limiting figure of dissolved oxygen, and "taking as a basis the rate of absorption of atmospheric oxygen by water and the rate of de-oxygenation of the admixture of various sewage liquids," the Commission states that it has "calculated the number of dilutions which would be required in order that the dissolved oxygen content of the mixtures should not fall below a certain figure." It has also noted the "effects produced at different seasons and under different conditions," by the discharge of "partially purified and unpurified sewage" into streams. Among the "different

*This was taken as a standard rather than the four-hour permanganate test because the five-day test corresponds more closely with observed conditions in streams, is more delicate, and is essentially a bacteriological test.

conditions" observed were depth and velocity of stream flow. Tables and text are used to show how the Commission deduced its "relaxed standards," which it has based upon actual tests with different classes of effluents and sewages and different grades of diluting water. In some of the tests depths of river water in feet were observed and also the length of time required for the "sewage liquors" and the river water to mix.

After working out to exact figures the necessary dilutions for different classes of effluent, the Commission chose three general classes of effluent, corresponding to the reductions in suspended solids, which may be expected from two kinds of tank treatment and no treatment at all, as stated more specifically in the summary of the report given further on.

As to the administration of the recommended standards, the Commission suggests that the normal standard should be fixed by "Statute or by Order" [departmental order?—Ed.]. Continuing, the report states:

> Compliance with this standard should be obligatory in regard to all discharges of sewage into non-tidal waters, and should be enforced by the Rivers Boards as a matter of routine, except in cases where it is shown to the satisfaction of the Central Authority that in view of local circumstances it is expedient to prescribe either an easier or a more stringent standard. In such cases the Central Authority should be empowered to approve special standards to be enforced by the Rivers Boards in the place of the general standard.
>
> The Central Authority will naturally pay special attention to waters, which are to be used for potable purposes, and, in the case of such waters, any application for the alteration of the general standard would be closely scrutinized.

The Commission considers the drinking water question so vitally important that it repeats the conclusions on that subject which it published in its Fifth Report. These may be briefly summarized as follows:

The Rivers Pollution Prevention Act of 1876 [rigid as it was—Ed.] was not designed to compel the purification of sewage to such a degree that the stream receiving it would afford a safe water-supply without filtration. The various systems of sewage treatment in use do not produce bacterially safe sewage effluents, as has been shown by exhaustive studies made for the Commission, and while those effluents might be rendered "fairly pure, bacteriologically," by further treatment the cost "would be serious." Furthermore, "a false sense of security" would result from such further treatment "unless, at the same time, storm overflows on sewers were abolished," since the discharges from such overflows "are frequently more impure, bacteriologically, than the normal crude sewage." The practicability of the abolition of storm overflows is doubtful, and even if a separate system of sewers were built it would be necessary to purify the storm sewage as well as the sanitary sewage to protect water-supplies if the sanitary sewage were to be purified for that purpose. The cost of separating storm and sanitary sewage, and of treating both so as to render the effluents bacteriologically safe "would in most cases be practically prohibitive"; and "even if this additional burden were placed on local authorities, the water of rivers would still generally require to be treated before it could be safely distributed for drinking purposes." The closing paragraph of the Commission's excerpt from its fifth report we reprint in full:

> Apart from the question of drinking waters, we find no evidence to show that the mere presence of organisms of a noxious character in a river constitutes a danger to public health or destroys the amenities of the river. Generally speaking, therefore, we do not consider that in the present state of our knowledge, we should be justified in recommending that it should be the duty of a local authority to treat its sewage so that it should be bacteriologically pure.
>
> We do not now suggest that the general standard should apply automatically to tidal waters as in the case of non-tidal waters, but we think that the principle which we have recommended in regard to special standards for streams might usefully be applied to tidal waters, where a standard is considered necessary.

Perhaps we should interject, that in an earlier report the Commission advised the formation of Rivers Boards for all the natural drainage areas of England (a few such boards have been in existence for many years) and that it also advised the creation of a Central Authority (which we presume might or might not be the present Local Government Board) to have general jurisdiction of the whole matter of sewage disposal. The Rivers Boards would deal directly with local authorities. This general plan is still favored by the Commission in its present report. As to how Rivers Boards should proceed in bringing local authorities to a compliance with whatever standards may govern in a given drainage area, we note that first of all it is assumed that they will "proceed by degrees," beginning with the larger towns. To quote:

> As a rule the areas draining into the head waters of a river are not densely populated, and consequently the pollutions derived from them, though they may be relatively large as compared with the volume of the small tributaries into which they discharge, occur at comparatively wide intervals, and do but little damage of a lasting character to the main stream. On the other hand, the pollutions arising from the larger centers of population, which are generally situated on the middle and lower reaches of a river, are not only more lasting in their effect, but owing to the extent of the requisite purification works, take longer to remedy.
>
> We think, therefore, that the Rivers Board might be well advised to turn their attention first to securing compliance with the standard by the larger towns whose works were as yet inefficient. The smaller communities might meanwhile employ this period of grace either in making provision for a scheme of sewerage and sewage disposal, which would be adequate for their increasing requirements, or, if their population were stationary or diminishing, in adopting some system of dry conservancy which would materially lessen the amount of pollution which entered the river.

Coming now to the close of the report, we reprint the Commission's own summary of its conclusions (the explanatory title being our own), as follows:

STANDARDS FOR SEWAGE EFFLUENTS TO BE DISCHARGED INTO NON-TIDAL WATERS, WITH CORRESPONDING STREAM DILUTIONS WHERE PARTIAL TREATMENT OR NO TREATMENT IS REQUIRED

(a) The law should be altered so that a person discharging sewage matter into a stream shall not be deemed to have committed an offense under the Rivers Pollution Prevention Act, 1876, if the sewage matter is discharged in a form which satisfies the requirements of the prescribed standard.

(b) The standard should be either the general standard or a special standard, which will be higher or lower than the general standard as local circumstances require or permit.

(c) An effluent, in order to comply with the general standard, must not contain as discharged more than 3 parts per 100,000 of suspended matter, and with its suspended matters included must not take up at 65° F. (18.3° C.) more than 2.0 parts per 100,000 of dissolved oxygen in five days. This general standard should be prescribed either by statute or by order of the central authority, and should be subject to modifications by that authority after an interval of not less than ten years.

(d) In fixing any special standard the dilution afforded by the stream is the chief factor to be considered. If the dilution is very low it may be necessary for the Central Authority, either on their own initiative or on application by the River Board, to prescribe a specially stringent standard, which should also reman in force for a period of not less than ten years.

(e) If the dilution is very great the standard may, with the approval of the Central Authority, be relaxed or suspended altogether. Our experience leads us to think that as a general rule, if the dilution, while not falling below 150 volumes, does not exceed 300, the dissolved oxygen absorption test may be omitted, and the standard for suspended solids fixed at six parts per 100,000. To comply with this test no treatment beyond chemical precipitation would ordinarily be needed. If the dilution, while not falling below 300 volumes, does not exceed 500, the standard for suspended solids may be further relaxed to 15 parts per 100,000. For this purpose tank treatment without chemicals would generally suffice if the tanks were properly worked and regularly cleansed. These relaxed standards should be subject to revision at periods to be fixed by the Central Authority, and the periods should be shorter than those prescribed for the general or for the more stringent standards.

(f) With a dilution of over 500 volumes all tests might be dispensed with and crude sewage discharged, subject to such conditions as to the provision of screens or detritus tanks as might appear necessary to the Central Authority.

EDITORIALS

A cousin to that famous (or infamous) worm that for years has been eating the life out of steel rails, has been found, or is in process of being found, in the form of an insect that destroys cast-iron pipe! Breaks in water mains at Syracuse, N. Y., according to the *Journal* of that city, showed the cast iron softened so that it could be cut like lead. A water-pipe manufacturer, whether the one who made the pipe does not appear, is said to have written to a Syracuse official advancing the theory that

some minute insects, which frequented the water there (at Atlantic City, N. J.) exuded an acid secretion, which in conjunction with the salts in the water, set up an electrolytic action and softened the pipe. Perhaps this is the case at Syracuse.

It is further stated that some of the Syracuse pipe has been turned over to the Chemical Department of Syracuse University for investigation. Ought it not to have gone to the Department of Biology, Division of Entomology? Or, perchance to the Division of Parasitology, since, whatever the form of life, this cast-iron pipe eater is unquestionably a parasite.

The Latest Concrete Failure

The failure of the reinforced-concrete garage in Detroit, described elsewhere in this issue, is another of those catastrophes which could easily have been predicted from the elements that went into the building. Consider what they were: an architect quite ignorant of structural design, the designer a commercial firm whose responsibility ended with the sale of the steel, the contractor a mere renting agent of equipment, a building department incompetent to guarantee observance of its own code, and finally a contract between owner and builder which encouraged cheap material and methods. Is it any wonder that the building had numerous members designed with too low a factor of safety, that the concrete was weak, that the methods of construction were improper and that death and loss were the ultimate end of the project?

Competent engineers can learn nothing from the failure that will aid them in future design. The errors which marked the design and construction have long since been set down as errors; the fatal consequence of disregard of good practice only emphasizes what was already known. The important lesson from the failure is that these errors were the natural result of the system under which the garage was built.

As long as architects turn over structural design to steel salesmen, and steel salesmen design structures which they do not follow beyond the drafting room and paying-teller's window; as long as contractors play with concrete framework as though it were a concrete sidewalk which cannot fall down, so long will honest concrete men be kept busy explaining that a certain failure was due to ignorance and negligence.

The concrete trade press has called this collapse "another workmanship failure." That is an incomplete characterization. The responsibility is just as heavy on the architect and the designer, even if the structure as designed would have stood forever if built by an honest and competent contractor. In the concrete business more than in any other branch of engineering, the engineer must design with an eye toward the construction and must have always before him a clause which should be in capital letters in every code of engineering ethics—"It is unprofessional for an engineer to sell a design the execution of which he cannot supervise."

Finally, the failure shows up clearly the futility of half measures in revising building laws. Detroit apparently is justly proud of its new building code, which is administered by well paid political appointees; perhaps now its citizens will understand that a few engineers might be of value to execute the law.

Selling Irrigation Water by Current Meters

A notable departure in the measurement and sale of water for irrigation is described on pp. 66 to 70 of this issue. It is the daily use of some 25 to 30 current meters on the 66 main-line delivery canals through which the California Development Co. supplies water to 245,000 acres of land in the Imperial Valley, Southern California. This use has necessitated the establishment of 66 meter stations and a meter-rating station, and requires the employment of a considerable force of hydrographers in place of the usual zanjeros.

Conditions pertaining to the Imperial Valley and to the large size of its irrigation system are in large part responsible for this departure in irrigation-water measurement, as may be learned from the article already mentioned, but the use of current meters and of other accurate engineering devices on irrigation works is sure to grow, and with it will come a demand for more hydrographers and engineers.

Two significant facts brought out by the article deserve attention: (1) the overcoming of the opposition to the use of current meters on the part of the mutual water companies and of the farmers which compose them, and (2) the part which the more accurate measurement of the water and also the more perfect control of its distribution has played in putting a once bankrupt property on a paying basis.

The New British Standards for Sewage Treatment and Disposal

To the brief editorial summary of the new British standards for sewage disposal into fresh-water streams, which appeared in our issue of Dec. 19, 1912 (p. 1159), we now add a somewhat extended abstract (pp. 76-78) of the report. While for use in this country the standards may require modification to adapt them to a considerable range of different governing conditions, they reserve careful consideration here because they are based on sound principles of sanitary science and public economy; they are closely correlated with the results obtainable from widely used and well approved methods of sewage treatment; they recognize the fact that no

one standard will suffice; they accept dilution as one of the governing factors of sewage disposal, and acknowledge that when the dilution is sufficient no treatment is necessary; they make freedom from nuisance or offense to the nose and eyes the ultimate standard for sewage disposal; they place the burden of health defense against sewage pollution on water purification—in short, the British standards deserve consideration here because they are based on the sort of everyday Anglo-Saxon common-sense that is bound to appeal to any and all persons possessing that quality on both sides the Atlantic.

The Engineer as a Guardian of Public Credit

The old idea that the engineer is a purely technical man who has no business to discuss or interfere in questions of economics, finance and commerce, was brought forward again by George Clinton, of Buffalo, in the recent Rivers and Harbors Congress at Washington. According to newspaper reports of Mr. Clinton's speech, he said: "Congress is a hundred times better informed than the engineers as to the necessity of waterway improvements. Engineers lose sight of the great economic principle involved, that the projects are not only meant to meet existing needs, but are also for the development and building up of traffic."

If Mr. Clinton's advice were sound and if Congress were to pay no heed to the advice of engineers, but listen solely to the promoters of waterway enterprises, the road to national bankruptcy would be a very short and steep one. The Government has in fact expended a good many million dollars on waterways in the hope that traffic would be developed on them, but the waterways remain unused.

It seems almost needless to say in the columns of this journal that it is as much the duty of the engineer who investigates a project to estimate and weigh its future commercial probabilities in order to make proper provision for them as it is his duty to make measurements, drawings and designs, select necessary machinery, and conduct the technical part of the work.

With all due respect to the abilities of members of the House of Representatives and the Senate, it may well be asked what proportion of them ever had any training or experience in the scientific investigation and estimation of industry, commerce or traffic? Fully three-fourths of the members of Congress are lawyers. If they were placed on the witness stand before a judge, they would almost without exception disclaim any expert knowledge in connection with industrial matters or matters of economics and traffic. An engineer dealing with large transportation problems must possess some degree of expert knowledge in this field to be competent for his task.

Fortunately for the country, the Congressmen themselves understand better the value of engineering advice than does Mr. Clinton. They fully appreciate that while the delegations of waterway promoters from this and that and the other district are each seeking appropriations for their own pet schemes without regard to the larger interests involved, the government engineers deal with the questions submitted to them from an unbiased standpoint, and with an expert understanding of technical and industrial conditions which is an essential to safe judgment.

Revelations Concerning New York State Highway Work

As most of our readers are aware, New York has embarked upon the largest venture in state highway construction of any state in the Union. It has already expended on the construction of improved roads the money raised some five years ago by a $50,000,000 bond issue, and at the last election in November an additional bond issue of $50,000,000 was approved by popular vote.

ENGINEERING NEWS has voiced the sentiment, held we know, by most conservative engineers, that the financing of this road work by the issue of long-term bonds, which will not become due until long after the roads built with it are worn out, is an economic crime.

But the State of New York is not only building roads with borrowed money which future generations will have to repay. It has permitted inefficiency and wastefulness and dishonesty to creep in in the expenditure of this borrowed money.

We need not take space now to rehearse in detail the scandals in connection with some of the early work done on the New York State roads. Part of the failures in that early road work were due to placing incompetent men in charge; part of them were due to the fact that even the ablest engineers were a good deal at sea at that time as to what sort of a road could be built which would stand automobile wear, and part of the troubles were due to common graft.

As the result of these unfortunate experiences, an act was passed in the administration of Governor Hughes, placing the state highway work under control of a non-partisan commission. It was hoped that under this commission there might be built up an efficient, non-political engineering organization, which should expend the state's money on good-road construction in the most economical and efficient manner possible. The prospect appeared brighter at that time that highway construction in New York might be placed upon a sound and economic basis than under any previous administration.

Unfortunately, as we believed and still believe, Governor Dix, when he assumed office two years ago, immediately promoted legislation abolishing the non-partisan highway commission and substituting a commission composed of the State Superintendent of Highways, the State Engineer and the State Superintendent of Public Works.

To lay a groundwork for advocating this proposed change, the Hughes commission and its engineers were charged with inefficiency and incompetency. The fact that many highways were rapidly going to pieces under heavy automobile wear gave sufficient color to these charges to make them pass muster, and the legislature made the change which the Governor recommended.

Had Governor Dix selected for appointment as Superintendent of State Highways an engineer of high standing and experience, with rugged ideas of what constitutes professional honesty and sufficient backbone to hold his own against opposition, New York might still have had honest and efficient conduct of its state highway work.

Instead of pursuing this course, however, Governor Dix appointed to this important office, charged with responsibility for the execution of many million dollars' worth of work, Wm. H. Catlin, a man nearly 70 years of age, possessed of neither engineering knowledge or experience, whose previous business life had been spent as a farmer and real estate dealer. In the fall of 1911, however, Mr.

Catlin's death occurred and C. Gordon Reel, Assoc. M. Am. Soc. C. E., who had been Deputy Superintendent of Highways, was appointed Superintendent.

At various times and from various sources during the past year or two there have appeared reports that the New York highway construction was being carried on with little regard to sound engineering principles. Statements definite enough for publication, however, have been lacking. The New York *Sun*, however, in its issue of Jan. 2, published a letter written by Superintendent of Highways Reel to Governor Dix, on Sept. 9 last, in which Mr. Reel makes definite categorical statements as to the methods which have been pursued in the conduct of the state highway work.

According to the *Sun*, Mr. Reel went to Governor Dix last summer and declared that he did not propose to be held responsible for the manner in which the state's road work was being conducted. After explaining the situation in detail, Governor Dix requested Mr. Reel to put his statements in writing, and the result was the letter which the *Sun* prints.

The gist of Mr. Reel's letter is that the specifications for much of the New York highway work have been so drawn as to require the use of materials furnished by certain concerns at a price much in excess of the cost at which equally good materials could be obtained in the open market.

It was proposed, for example, to use a patented reinforcement in certain concrete roads which were being constructed. The cost of this reinforcement was 4½c. per sq.ft. at the factory, whereas an equally good or better reinforcement obtainable in the open market could be had at a cost of 1.3c. per sq.ft. This would make a difference in the cost of a 16-ft. road of over $2800 per mile. Mr. Reel also states that 3000 ft. of this expensive construction which was actually used on a roadway in Saratoga County proved a failure. Had the Division Engineers in the state service adopted this expensive reinforcement in their designs to the extent to which their instructions from their superiors originally required, Mr. Reel estimates that the additional cost to the state would have been over a quarter of a million dollars.

Mr. Reel next reviews the department's experience with the so called "rocmac" construction. He states that the specifications for 16 roads, aggregating over 65 miles, were changed in the office of the Chief Engineer to require "rocmac," this change being made after the specifications had been drafted by the Superintendent, the Chief Engineer and six Division Engineers in conference. We quote as follows from Mr. Reel's letter:

> Rocmac has been sold at varying prices, 20 cents, 22 cents and 28 cents, the highest price being 30 cents per gallon. As soon as the 65 miles was specified the price became 45 cents per gallon. At this extra price of 15 cents for the specified mileage, the extra cost to the State would be (allowing for the difference between the Imperial gallon and the U. S. gallon) $53,310.
>
> The whole rocmac proposition created a scandal throughout the state and of the 13 roads specified, supplementary agreements were etered into on nine roads, substituting 7- and 9-in. asphalt bituminous construction for the rocmac for 45.8 miles and at a saving of $15,550.
>
> The four roads, which were allowed to remain rocmac have given endless trouble. The specifications are not practicable and one of these was recently changed to another type of construction.

Mr. Reel then narrates the department's experience with the so called "dolarway" construction. He states that strong influences were exerted by men in high authority in the department to have this construction specified for about 300 miles of road, which were put under contract in June and September last. This construction consists of covering a concrete road with a thin coating of bituminous material. Mr. Reel states that the prices charged for the material were 10c. *per sq.yd.* for the material delivered in tanks and 11c. per sq.yd. in barrels. Allowing 0.4 gal. of the material per square yard of coating, this would be equivalent to a price for the material of 25c. per gal. in tanks and 27½c. per gal. in barrels. Another manufacturer of bituminous products, however, offered to supply bituminous materials, which Mr. Reel states were identical with this high priced material, at 6½c. per gal. in tanks and 8½c. in barrels. The state is now using this cheaper material, although, according to Mr. Reel, men of prominence in the department are still making strenuous endeavors to have the more expensive materials used.

Mr. Reel then takes up the so called "Hassam pavement," which consists substantially of building a concrete roadway by covering the road with broken stone and then filling the interstices between the broken stone with grout. Mr. Reel states that the State Highway Commission decided to use about 10 miles of this pavement as an experiment, and in the contract letting last April it was specified for a road 5.6 miles long in Chenango County and one 5 miles long in Schoharie County. We quote *verbatim* from Mr. Reel's letter as follows:

> The total royalty at 85 cents per square yard amounted to $85,052. Subsequently the Hassam company reduced its price to 25 cents per square yard and has now reduced it to 10 cents per square yard. At this latter price, 10 cents per square yard, I think their pavement is available and we will use a considerable amount of it.

Mr. Reel quotes further examples where bituminous materials were sold to contractors for state road construction at 9c. per gal., but for repair work done by the state with its own forces the same material was charged to the state at 13c. per gal. He also states that he found upon inspection that certain roads where these bituminous materials were being used were failures.

In connection with Mr. Reel's letter, it is of interest to note that Governor William Sulzer, who assumed office on Jan. 1, in reappointing Duncan W. Peck State Superintendent of Public Works, informed him that notwithstanding the law which makes him a member of the State Highway Commission, he should have nothing to do with the state highway work. Mr. Sulzer is also quoted by the *Sun* as saying: "I have no hesitancy about saying that State Engineer Bensel has all he can do with engineering and surveying. Neither will he have any more to do with state highways, either in building them or maintaining them. My message will give the people the key to what I propose to do about state highways."

Reference to this matter in Governor Sulzer's message to the Legislature was as follows:

> In the near future I shall communicate to you some further views by way of recommendations regarding the building and maintenance of good roads and the complete reorganization of the Department of Highways into the Department of Good Roads, having a single responsible experienced and competent head with full powers to do the work required along safer, and better and more comprehensive lines, in order to promote greater economy and a higher degree of efficiency in the future building and maintenance of good roads.

In his annual report just issued, State Engineer Bensel himself says:

> It is my opinion the method of organization should be

changed and the Highway Commission put in control of the work as a commission, or that it be placed under a single head. So much work is put on the State Engineer that it is not possible for him to attend to the work required in the Department of Highways.

It should also be said that Governor Sulzer has declared his intention to appoint an investigating commission with power to inquire into the conduct of state work in various departments, and it is understood that the conduct of the state highway work is one of the matters which the investigators will take up.

We have deemed it important to put the above facts on record for the defense of the engineering profession.

If and where the New York highway work proves a disappointment to the taxpayers of the state, the blame need not be laid at the door of the engineering profession. That profession will not stand for incompetency or graft. We believe the rank and file of the engineers on the New York state highway work desire to build the best roads which can be built for the money expended, and have no sympathy with attempts to divert the state's road funds to furnish exorbitant profits to private concerns.

New York, as we have said, has embarked upon the largest experiment in state highway construction of any state in the Union; but it has allowed politics to dominate the work and the natural result has followed. The taxpayers and voters of New York have themselves to blame in that they have permitted this great public work to come under control of a political organization and have thereby opened the door wide to inefficiency and worse in the connection with the expenditure of a hundred million dollars.

It is refreshing to turn from New York's work in state highway construction to the work in Massachusetts. The amount of money which Massachusetts has spent in state road building is a mere trifle compared with the millions that New York has appropriated; but the work in Massachusetts is a model which is studied by road builders from all over the United States, whereas a large part of New York's road work is chiefly notable as a monumental illustration of how not to do it.

As most of the readers of ENGINEERING NEWS know, the Massachusetts highway work has been from the outset in charge of a commission made up of three prominent citizens who have carried on the work on business principles without regard to politics. It is of interest in this connection to quote the following extracts from an address given by Col. Wm. D. Sohier, Chairman of the Massachusetts Highway Commission, before the American Road Congress at Atlantic City last October:

> The primary need in any state highway law is that the taxpayers' money shall be spent by men who know something about the business of road building. In such a law you need more than anything else tenure of office, and nobody in office who is not competent and trained for his work.
>
> The best asset in the Massachusetts Road Department today is the men we have educated and trained. Our engineers are men who have graduated from some technical school and who are when they graduate not worth very much. We hire them for $900 to $1200 a year and in two or three years they really know something about road building.
>
> It is nonsense to talk about getting expert advice and expert knowledge without being willing to pay what it is worth. Our experience in Massachusetts is that various other States are coming in and saying to our men whom we have educated, "you are worth more money to us than you are to them. Come out West."
>
> They took some of our engineers to New York, and they stayed there until there was a political change in administration and now they are back with us!
>
> The man does not live who can do what the New York Highway Commission set out to do and that is start in at once, with no organization, and spend $5,000,000 the first year on road construction and spend it economically. In Massachusetts we have had an organized highway force a good many years, yet it would be somewhat of an undertaking for us to organize next year a sufficient force to spend a million dollars rather than half a million dollars and secure with it as good results on each mile as we now secure when spending the half million dollars.
>
> When the New York State Highway Commission [appointed by Gov. Hughes] went into office, they found that the State of New York had already spent $18,000,000 in constructing state roads, and $3,000,000 was needed to put these roads back into good condition, although none of them were more than four years old and some were only one year old.
>
> A road as a piece of property is at all times a liability, and if you do not keep it up, its construction has done the state, and the country, and the good-roads movement more harm than can be done in any other way. If the men who are interested in highway construction will get together and formulate a plan by which road building shall cease to be political and be placed in charge of experts, they will do more real good than can be done in any other way. Roadbuilding under the Massachusetts Highway Commission has nothing to do with politics. I don't know the politics of more than two of the engineers out of seventy-five.

We earnestly commend Colonel Sohier's remarks above quoted to the attention of Governor Sulzer and the New York Legislature. Massachusetts adopted more than a quarter of a century ago the commission plan of conducting the great engineering works which the state has carried out; the members of the commissions have been appointed by the Governor and have been almost invariably men of high standing and reputation for business ability and integrity.

As a result, the engineering works carried out under state control in Massachusetts have been almost without exception completed without scandal and the state funds have been expended in an economical and efficient manner.

New York also has adopted the commission plan for the conduct of many of its great works, and where the commissions have been made up of capable and honest men, good and honest work has invariably been secured.

The State of Maine is about to expend $2,000,000 on highway construction and the State Board of Trade has secured advice from an expert of the Federal Office of Public Roads as to the proper organization to control this expenditure. The expert advised that the highway system in Maine be placed in the hands of a highway commission to be composed of three members appointed by the Governor and Council, the original appointees to serve three, two and one years, respectively, and thereafter each commissioner to serve three years; the commissioners so appointed to receive a salary of $500 per annum and actual expenses when traveling on official business.

In dealing with the New York highway situation, it is the future that is important rather than the past. Whatever waste or worse has occurred in the expenditure of the first $50,000,000 of New York's road fund is now chiefly important as a guide what to do (and what not to do) with the second $50,000,000. The desideratum is a non-political organization under which competent engineers can be secured for the work and sound engineering methods can be adopted. If Governor Sulzer will create such an organization, there is good reason to hope that succeeding Governors, even though of a different political party, may realize that it would be good politics, as well as an act in the public interest, to leave such an organization undisturbed.

LETTERS TO THE EDITOR

Recent Thefts of Surveying Instruments in New York City

Sir—It may be of interest to the engineering profession in general to publish the following in a prominent place in the next issue of your publication, and thereby put everyone concerned on guard.

Since Sept. 1 of this year there have been numerous thefts of surveying instruments reported to our firm, and we keep a record of such stolen instruments with a view of locating or retrieving the same if offered for sale or repair.

In the last two or three months there has been a regular epidemic of thefts. There have been reported as stolen one level and five transits of various makes, from different offices in various parts of New York City. In each case the method of procedure has been exactly the same. The instrument was removed from the box and unscrewed from the running or sliding board, the latter replaced in the box and the empty box left standing in its usual place. For this reason it has been in most cases impossible to establish the exact date of the theft, as generally there had been no occasion to use the instrument for some weeks, and the theft was not discovered until the instrument was again wanted for use on another job.

From the foregoing it would seem that the same person has been the offender in each case. The various losses have been reported to the police, but as yet no results have been produced by this method.

We consider it our duty to issue this warning to engineers in general to prevent further losses, and we hope that the culprit will be speedily apprehended.

KOLESCH & Co.

138 Fulton St., New York City,
Dec. 23, 1912.

Increased Flow of Springs Just before Rains

Sir—During the last summer and fall I have been studying the Scioto River watershed to the northwest of Columbus, and while so engaged I encountered a phenomenon regarding most of the springs in that section.

A large number of the springs on the west side of the Scioto River fluctuate with the amount of water in the ground. That is, in very dry weather the flow is less than in a wet season, as would be expected, but the thing that struck me as most remarkable was the fact that most of the springs increased their flow before a rain. Some of the springs increased in flow as much as 100% and this for a period of from 1 to 48 hr. previous to any sign of rain.

This fact was first called to my attention by one of the axmen in the party predicting rain when the sky gave every indication of continued fair weather. On questioning him as to his reason, he said that the Quarry Spring was flowing strong, which was a sure sign of rain in 48 hr. I at first passed it without thought, but it was again brought to my attention by some of the oldest inhabitants.

Quarry Spring flows from the side of a rocky point. A small basin has been formed by hand and a 2-in. pipe arranged for the overflow from the basin. In very dry weather the pipe has a capacity of about twice the flow of the spring. Generally this spring will increase its flow before a rain, commencing sometimes 48 hr. before any indication of rain. I do not say that it will increase its flow before every rain, but that it generally does so. The variation of flow of this spring is based on the time required to fill a bucket at the end of the pipe.

There are numerous instances of a similar character covering a strip of country extending 10 miles along the west bank of the Scioto River. My conclusion was that every time there was a decrease in the air pressure the spring increased in flow and that this same decrease in air pressure caused the rain—the latter effect following the lower barometer more slowly.

Evidently the source of the springs is at a considerable distance from the outlet, so that the same atmospheric conditions do not exist at the source as at the outlet.

The driven wells in this vicinity generally give cloudy water before a rain, but the reason I have suggested for the increase in spring flow will not explain the cloudy water from wells.

S. P. BAIRD.

315 Ninth Ave., Columbus, Ohio,
Dec. 15, 1912.

The Sheet-Pile Cut-off on the Port Angeles Dam

Sir—The writer was much interested in the descriptions of the accident to the dam at Port Angeles, Wash., appearing in your issues of Dec. 5 and Dec. 26, 1912. To the writer it appears more than probable that the unfortunate location of the steel sheet-piling at a point 8 ft. down stream from the downstream toe was largely responsible for the failure.

Although it is not so stated in the article, it is possible that it was intended to unite the sheet-piling to the body of the structure by a heavy concrete apron. Even so, it was the height of folly and ignorance to raise the head on the dam while the structure was in such an incomplete condition.

Through a gravel bed, such as appears to have underlain this dam, a flow of water is constantly in process. When a dam is placed on such a bed of gravel the danger is that the head of water in the pond back of the dam will so increase the velocity of the water flowing through the gravel that when it issues from the river bed below the downstream toe it will have sufficient velocity to carry away the particles of gravel and thus undermine the foundation of the structure. Cut-off walls, sheet-piling rear aprons and fore aprons are used to increase the resistance to this flow by forcing the water to take a longer path through the gravel, thus increasing the

friction head and lowering the velocity at exit below the danger point.

In the case of the Port Angeles Dam, the driving of the sheet-piling below the downstream toe had the same effect as the partial closing of a sluice gate; the velocity through the remaining opening or openings was greatly increased. Or to put it differently: The area of discharge before sinking the sheet-piling comprised the entire cross-section of the gravel bed at this point plus the horizontal area from this point to the downstream toe multiplied by the percentage of voids in the gravel. Through driving the sheet-piling this area of discharge was decreased by about one-half the area of the sheet-piling driven. The effect of this was greatly to increase the velocity of the water issuing from the horizontal area of the gravel bed between the sheet-piling and the downstream toe. The foundation was considered dangerous before; it was doubly so after the addition of the sheet-piling in its chosen location.

Had steel sheet-piling been driven at or near the upstream face of the dam to impervious strata; or failing in this, had it been driven to the greatest practicable depth and impervious fore and rear aprons added of sufficient length to force the water from the pond to take a path through the gravel equal to, say, 600 ft. before it could appear in the river below the dam, the velocity of the water would have been so reduced through friction that it could not move the gravel. Even if there had been a cut-off to an impervious layer, the dam should have had a fore apron to protect the gravel below the dam from the overflow.

The method of construction seems to have been a bit peculiar in that the superstructure of a dam to be under a head of over 100 ft. was constructed before even investigating the necessary depth of cut-off. It is possible, however, that this may have been justified by the expediency of construction.

JOEL D. JUSTIN.

Harrisburg, Penn.,
Dec. 31, 1912.

The Work of the International Association for Testing Materials

Sir—I only read the articles in ENGINEERING NEWS, of Sept. 19 last, on the Sixth Congress of the International Association for Testing Materials, after my return from America. Although very well satisfied with the thoroughness and correctness of your report of the proceedings of the congress, I was much pained by the editorial in that issue on the results attained by the congress—an editorial which, as a man well acquainted with the work of the association, I may say does it much injustice.

The editorial declares that the work accomplished by the last congress is very poor, and that this shows the futility of the association and its congresses. Does the writer really believe that the discussions on the notched-bar test, on the constancy of volume, on the testing of plastic mortars and many other subjects, as well as the work of the association which went before, on which the discussions were based, are useless because they did not lead to any positive resolutions? Does it signify nothing that through the handling of these questions by the association, the specialists in various countries are forced to regard these testing methods of their own, which are sanctioned through use, from the other standpoints, and to examine them? And does the international experience on certain objects, which the association in dealing with them systematically gathers, not serve the best interests of each country?

The object of the association is above all that of reconciling, by its work, the contrary views on methods of testing, the differences of some specifications and to unify them.

The policy followed by the association consists in actively working for this unification by the proposal of certain standards in the committees, by having the same examined by leading testing laboratories of all countries and by national societies. But the association does not confine its work, as the writer opines, by passively waiting until certain truths have established themselves in the whole world, so that the association only requires to put the seal of its consent upon them without further trouble.

This preparation is long and difficult, but it brings useful work with it, which only finds its last visible expression in a final conclusion.

The uniform methods recommended by the Brussels congress for testing metals, alloys, hydraulic cements, wood, and pipes of clay, stone and cement, which are recognized throughout Europe, but which are unfortunately little known in America, were the first great results of much arduous work.

At the last congress, resolutions on uniform nomenclature were agreed upon, a result of great value, although underestimated by the writer of the article, and it is to be hoped that further important resolutions on unified methods and on principles of specifications, as the result of continuous work, will be arrived at in the near future.

Those who know the difficulties bound up with international unifications will acknowledge the fact that they cannot be arrived at in a short time.

The testing of materials is not a purely theoretical question, but involves tasks with which the industrial conditions of the various countries are closely connected. The difficulties which already exist through this, for the unifying of the methods of testing, are further aggravated in the unification of specifications as, for instance, for iron and steel. It is to entirely mistake the range of the question and its connection with the unequal conditions of production in different countries, should the obstacles which stand in the way of the satisfactory solution of this task be considered of so little importance that the association could have easily solved them. It would be grossly unjust to condemn the efficacy and usefulness of the association because it has not as yet succeeded in establishing international specifications, which must, however, offer more weight of reason for general recognition than any existing national standards.

But even the apparently negative resolution of the congress on this question is no deadlock, but is an inducement to the carrying on of the preparatory work of enlightenment, which, as has been shown, must precede the solution of this difficult problem and which must be undertaken by an international body.

Besides this, the value of the international association lies not merely in its attempts at unifying the methods for testing and specifications, but also in the useful impulse which is given by it, as the central point of research

work of the whole world, to all countries, even to the most progressive and leading ones. The most valuable idea for which America, among others, has to thank the international association was that of the foundation of the American society. The great impulse to the practical utilization of metallography given by Osmond at Stockholm, or the impulse to the testing of hardness given by Brinell at Budapest, or the example of the model laboratory at Brussels, demonstrating to the world the application of the newest methods of testing metals—to mention only a few points of the earlier congresses—such impulses gave to the congresses an importance which really cannot be replaced by the technical press, however developed.

The last two congresses were also rich in fresh impulses and opened up new vistas of work for the near future.

I believe that the writer of the article, in spite of his intention to speak the whole truth about the association, has overlooked many good points of its work and of its congresses, though he has at the same time acknowledged the great value of the congress papers and the importance of the personal intercourse between first-class experts of the world brought about by the congress. He placed, on the other hand, certain deficiencies in too bright a light, deficiencies, such as the organization of some committees, which are about to be obviated.

ERNST REITLER,
General Secretary, International Association for Testing Materials.

Nordbahnstrasse 50,
Vienna, Austria.
Nov. 15, 1912.

Selling Stock in a Railway Automatic Stop Company

Sir: The attention of the management of this company has been called to a bulletin, No. 16, issued under date of Dec. 9, 1912, by the International Signal Co., of 104 West 42d St., New York City., addressed to the stockholders of that company, the first paragraph of which bulletin reads as follows:

> It gives us great pleasure to announce that the officials of the Delaware, Lackawanna & Western R.R. have closed an agreement with us to make such an installation of our new automatic train stop on that great system as will comply with the requirements of the Block Signal and Train Control Board of the Interstate Commerce Commission; and we are now hard at work getting new machines built to make this installation.

The bulletin closes with an appeal to the stockholders to buy some of the treasury stock of the company, and attached is a blank to be used in subscribing to the stock.

The information contained in the first paragraph of said circular, as also throughout the entire circular, is grossly misleading as to the arrangement the above named Signal company has made with the D. L. & W. R.R. Co. Briefly stated, this arrangement is as follows:

After an examination of the mechanism of their device, as shown in a model in the office of the Signal company, this company on Nov. 2 by letter authorized the Signal company to install one of its signals on a branch line of our road, the mechanism for the test to be put on a single engine; this to be done solely at the expense of the Signal company, the railway company's officials and employees to render the necessary assistance in making the installation and in conducting tests. Up to this date the apparatus for the single signal has not been furnished, we being advised that the Signal company is busy in its shops making up parts for the apparatus and does not expect to have it completed ready for installation before Jan. 1.

This information is given to the public as, from inquiries which our company has had from different sources, it is evident the Signal company is securing subscriptions to stock from railway employees, based on the misrepresentations contained in its bulletin above referred to.

G. J. RAY.
Chief Engineer, Delaware, Lackawanna & Western R.R.
New York, Dec. 18, 1912.

[A proof of the above letter was submitted to the International Signal Co., to give opportunity to present its side of the case in the same issue in which the above letter was printed. Its reply follows.—ED.]

Sir—We desire to thank you for calling our attention to the letter of G. J. Ray, Chief Engineer of the Delaware, Lackawanna & Western R.R., regarding our selling of Treasury Stock to our stockholders.

Briefly, our Bulletin No. 16 was mailed *only* to stockholders of this company, and *not* to "railroad employees" (unless they were also stockholders), nor at all to the general public. As will be noted from the number of the Bulletin, it has been the practice of the company to keep in touch with its widely scattered stockholders through bulletins issued from time to time, telling of the vicissitudes, good, bad and indifferent, of our corporation; and as was intended, and as we construe it, our Bulletin sets forth that the installation on the Lackawanna is purely for testing purposes, and its success or failure has no binding action of any kind on that railroad, and we certainly do not agree with any opinion that it was misleading.

We would like to call attention to the facts that only Treasury Stock, and *not* personal stock, was offered for subscription, and that every cent of the proceeds from its sale goes directly into the company treasury for a working capital, and not into the pocket of any individual; that even the Treasury Stock is offered only to present stockholders, practically all of whom have been stockholders for over six years and have been kept informed of company conditions; and that this Bulletin specifically states that the subscriptions are being solicited for the very purpose of making this *testing installation* and supervising the tests thereof.

THE INTERNATIONAL SIGNAL CO.,
By JEAN F. WEBB, JR.,
Secretary.

104 West 42d St.,
New York City.
Jan. 2, 1913.

NOTES AND QUERIES

In the article by A. C. Arend, entitled "Investigation of a Compound for Producing Dustless Concrete Floors" (Engineering News, Dec. 19, 1912), the following correction should be noted in Table II (p. 1099). The loads recorded were total loads applied in each instance on 4 sq.in. (not lb. per sq.in. as printed) and the total load on the iron-mixed cubes equals 91% of that on the neat cubes (not 19% as printed).

In the article in the issue of Jan. 2, 1913, entitled "Progress in Military Explosives," the cuts in Figs. 7 and 8 (p. 24) were inadvertently interchanged.

Failure of a Reinforced-Concrete Building, Detroit, Mich.

On Nov. 15, 1912, a three-story reinforced-concrete garage in course of construction in Detroit, Mich., collapsed while concrete was being laid, and carried down a number of workmen in the ruins. Three men were killed and a number of others were injured in the wreck. We have refrained from commenting on the disaster until

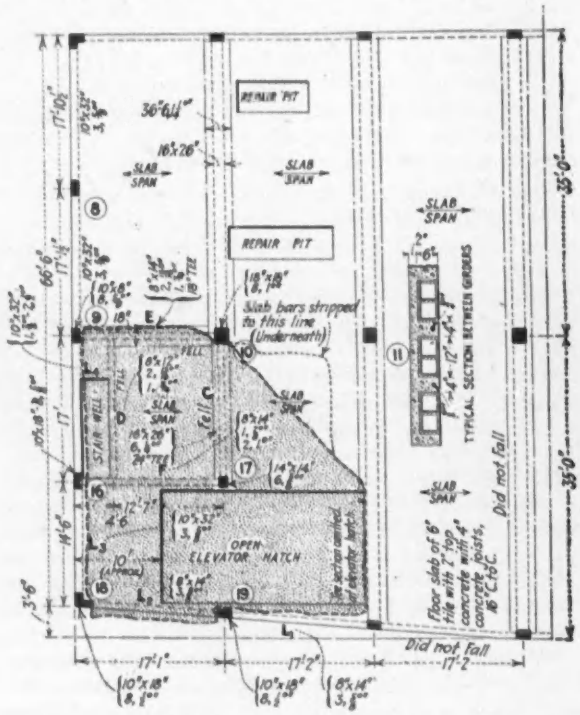

FIG. 1. PLAN OF PORTION OF SECOND-FLOOR FRAMING COWHEY BUILDING

after the coroner's inquest had been completed and, also, until a thorough investigation could be made of the design and the construction of the building. We give below the facts brought out by the inquest and by our own investigation.

The building in question was being built for S. E. Cowhey, near the corner of Larned and St. Antoine Sts., to be used as a garage and automobile repair shop. The general design was made by Frank L. Malby, a local architect with no particular experience in reinforced-concrete construction, and his drawings were turned over to the Gabriel Reinforcement Co., a local concern, for the structural design. This company made the drawings from which the material was ordered and according to which the building was put up. The contract was let to M. B. Everham, a local builder, under a peculiar form of contract, the details of which are not all available. It appears, however, to have been a form of force-account, with the additional bonus to the contractor of all the building material left after completion. In effect, the contractor did little less than to furnish equipment, the general supervision of the work being in the hands of a hired superintendent, who, it seems, resigned before the end of the work, leaving the supervision to the hoisting engineer on the job.

The plans were submitted to the Building Department of the City of Detroit, but this office, though working under an excellent code, is not provided with sufficient technical force to pass upon reinforced-concrete design. Consequently the approval of the department was merely formal. We are informed that there is no one in the department competent to design a reinforced-concrete structure.

The building was a three-story and basement structure, 120 ft. deep, 70 ft. wide at the street front, and 66 ft. 6 in. wide at the back alley.

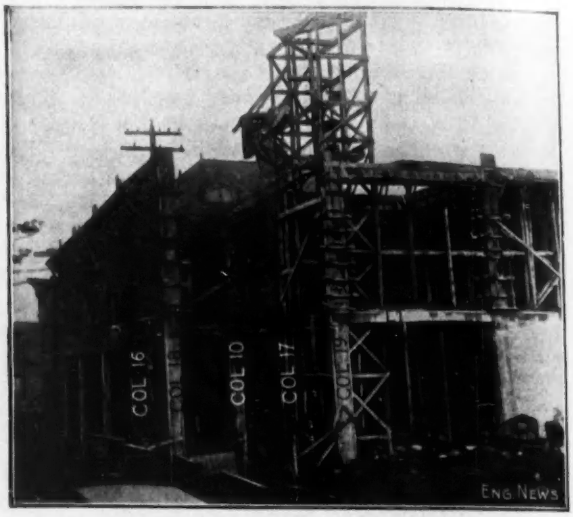

FIG. 2. VIEW LOOKING TOWARD SIDE OF BUILDING IMMEDIATELY AFTER THE COLLAPSE

The layout was of the ordinary beam-and-column type, carrying tile-and-concrete floors of varying spans. The columns were rectangular in section, reinforced with straight "Gabriel ovoid" bars, and rested on square pedestals on good footings. Most of the beams were of T-section (with exceptions as noted below), reinforced with "ovoid" bars in the bottom, turned up to give tensile value over supports and tied together with the typical "Gabriel" loops, as stirrups. The slabs were of the tile-and-concrete type shown in the detail on Fig. 1. Brick curtain walls formed the main showing faces. It is not clear whether the third floor was supposed to be the roof

FIG. 3. LOOKING TOWARD BREAK BETWEEN COLUMNS 9 AND 10
(Beam L 4 broken off after failure of rest of structure.)

or a working floor, but that is not material at this time.

The concrete work was started last Fall, and on Oct. 15 the casting of the second floor was completed. The work then proceeded so that on Nov. 15, 1912, the third floor in the rear of the building was being deposited, when, after a brief warning by cracking supports and sagging girders, the month-old second floor collapsed with the disastrous results noted. The drawing in Fig. 1 shows the rear bays of the building and indicates in the hatched area the portion of the second floor that fell. Fig. 2 is a view taken immediately after the collapse, looking toward the corner that failed.

Looking now at Fig. 1, it will be seen that the members which fell on the second floor were beams *C, D, E,*

FIG. 4. VIEW OF BREAK AT TOP OF COLUMN 17

F and L_2, together with the slabs held up between these beams. No column failed, but in every case the above-noted beams pulled out of their respective columns. For the sake of safety the tottering column 16, with connecting beams, were torn down after the accident, leaving the break at column 9, beam L_4, as shown in Fig. 3. In most of the breaks between beams and columns there was no evidence of any reinforcing connection between the two members other than an inch or two intrusion of the beam rods into the column. These pulled out, leaving holes in the columns.

At the time of the failure, the third floor, being deposited, was supported by the second floor on struts taken from under that floor. The second floor itself was not held except by its own strength and by occasional posts of no particular strength. In addition to the dead load of the floors themselves the structure was also subject to the shock and vibration of the concrete elevator which was located in the elevator hatch at the side of the building, as shown in Fig. 2. The framework for this elevator was connected to the concrete forms.

A combination of bad practices was evidently the cause of the failure. The original architect apparently had nothing to do with the building, except to provide general plans; the structural designers did not follow their design beyond their office; the city did not pass on the design; the contractor did nothing more than to furnish equipment, and the final superintendent was not competent to supervise reinforced-concrete work. So much for the human agencies. The physical constituents of the building were equally bad; the design is decidedly weak in parts, and the concrete, though supposedly the 1:2:4 gravel mixture required by the city building ordinance, was so weak that it could be broken by the hand one month after the collapse. It was testified at the coroner's inquest that samples of the concrete taken from the building broke in compression at from 400 to 500 lb. per sq.in. This weakness is partly due to poor mixing and insufficient cement, though low temperatures may have had something to do with it. Weather-bureau records show temperatures as low as 25° F. on Nov. 1 to 3, two weeks after the second-floor concrete was placed.

In the design, attention is called to beam *D*, an 8x12-in. prismatic section, reinforced with 1.84 sq.in. of steel. At the time of failure it is probable that the concrete in this beam was stressed in compression up to 1500 lb. per sq.in. The structural designers claim that this beam was built with a T-section, but the drawings do not call for such form. The concrete in beam *C* was also stressed far above the design unit value of 650 lb. per sq.in. allowed by the code. At the same time the lack of connection between beam and column (a fault of construction, apparently, rather than design), added to the weakness of the frame. The slabs proper seem to be within safe limits of design.

The coroner's jury, on Dec. 18, brought in a verdict of negligence against the Gabriel Reinforcement Co., which was responsible for the design, and M. B. Everham, the contractor who was supposed to be in charge of the work.

❦

American Electric-railway statistics have been compiled and published in the "Electric Railway Journal" of Dec. 7, 1912. Of all the figures there shown, we have reprinted below only the totals for the various groups of states and the country as a whole. It is stated that, in the compilation, effort was made to confine the figures to operating companies and that intercorporate relationships were taken into account with proper allowances for duplications. The table represents the condition at the end of the calendar year 1911.

	Number Companies	Miles Track	Cars	Capital Stock Outstanding	Funded Debt Outstanding
New England States	121	6,035.79	15,792	$214,102,800	$152,586,543
Eastern States	497	12,395.40	34,684	832,926,963	1,019,654,702
Central States	315	14,570.30	25,844	679,069,110	789,332,393
Southern States	90	1,991.07	4,005	172,031,620	138,240,400
Western States	186	6,035.93	11,132	535,055,660	324,520,500
All States	1,209	41,028.49	91,457	$2,433,186,153	$2,424,334,538

A Drawbridge Stalled by an Unusual Accident

A failure in the machinery of the swing span of the Delaware, Lackawanna & Western R.R. over the Passaic River at Newark, N. J., on the morning of Dec. 3, interrupted traffic for about three-quarters of an hour. The failure occurred about 8:30 a.m., near the close of the morning rush-hour traffic, but delayed a large number of trains. The accident was caused by a peculiar breakage of parts in the operating machinery. A description of

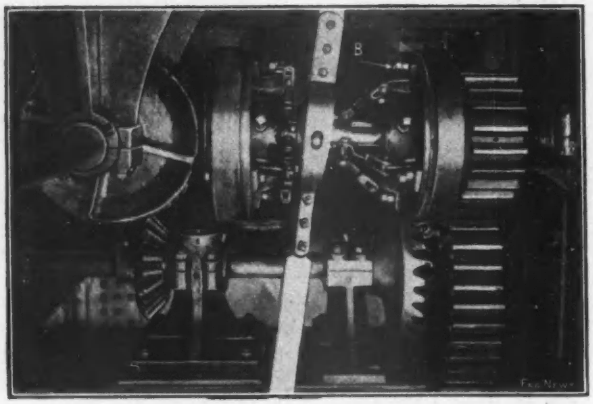

FIG. 1. FRICTION CLUTCH ON MOTOR SHAFT OF D. L. & W. R.R. PASSAIC RIVER BRIDGE, NEWARK, N. J.

(Bolt B broke Dec. 3, and was thrown between pinion and equalizer gear of swinging motion, resulting in fracture of a $6\frac{7}{8}$-in. rack-pinion shaft.)

the accident has been furnished us by G. J. Ray, Chief Engineer of the railway company.

This drawbridge is a double-deck swing, having two tracks on the upper deck and one track on the lower deck. It weighs about 1000 tons. The structural arrangement is unusual in that the bridge is of the pure center-bearing type and has wedge bearings on the center pier under the middle point of each truss, which re-

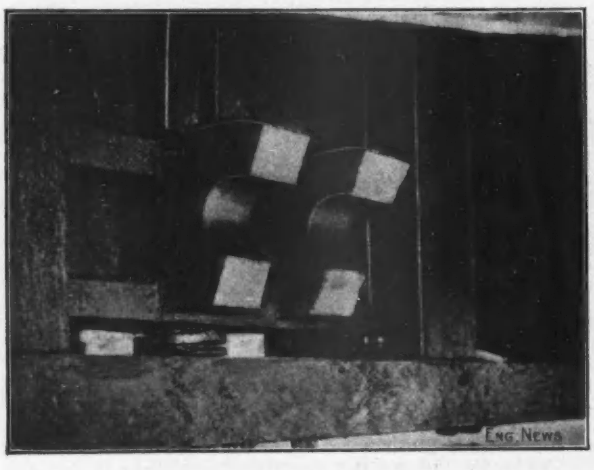

FIG. 3. BROKEN LUGS OF WEDGE-OPERATING NUT, PASSAIC RIVER BRIDGE

lieve the center bearing when the bridge is closed. The swinging motion is actuated by two pinions on vertical shafts meshing with a circular internal gear laid on the masonry pier. The two wedges are each driven by a vertically traveling nut, which is connected to the wedge by an inclined link exerting outward pressure by toggle action as the nut goes down when the screw is turned.

All this machinery is operated by a single electric motor located under the floor of the bridge near the center. The motor shaft, transverse to the center line of the bridge, carries a duplex friction clutch of the ordinary cone friction type, so arranged that either one side of the clutch or the other may be connected up to the shaft. One side of this clutch is coupled to a pinion (see Fig. 1) meshing with a differential gear on a shaft con-

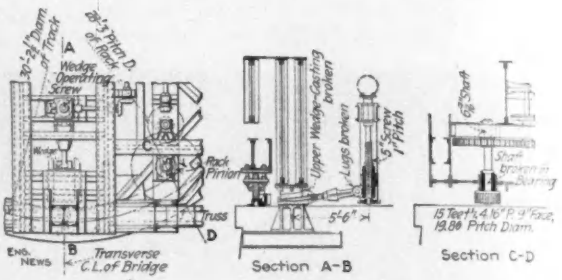

FIG. 2. PART PLAN AND SECTIONS OF OPERATING MACHINERY, D. L. & W. R.R. PASSAIC RIVER BRIDGE

necting with the swinging-motion pinions, shown in the part plan, Fig. 2. The other side of the clutch is connected by shafting and gearing to the screws which operate the two wedges, also shown in Fig. 2. From this wedge shafting are also driven two longitudinal shafts leading to the end lifts.

The break which started the accident occurred in the friction clutch on the side which drives the swinging motion. This clutch is shown in the photograph reproduced as Fig. 1 herewith. The bolt marked *B*, one of four bolts fastening the link bracket to the follower block, broke while the bridge was being closed after passing a vessel. Apparently the link and bracket with part of the bolt flew out and, in striking some part of the structure or machinery, bent the bolt and broke off the link. In this action the bolt was thrown between the pinion and differential gear of the swinging motion, at the right in Fig. 1. While the jamming of the bolt between pinion and gear effectively blocked the motor, the whole momentum of the swinging bridge was at the other end of the drive, acting upon the two rack-pinions, and the $6\frac{7}{16}$-in. shaft of one of these pinions broke in the bearing just over the pinion.

Immediate inspection showed the broken follower bolt, but did not reveal the break of the pinion shaft, as this was concealed in the bearing. The bolt and follower link of the clutch were replaced, and to test and adjust them the bridge was swung a short distance. In this operation the pinion whose shaft was broken fell out and was caught between the upper wedge and the masonry; it sheared off the upper wedge casting and broke off the lugs of the nut operating the wedge (see Figs. 2 and 3). Notwithstanding this serious breakage, the bridge was finally closed with only three-quarters of an hour delay to traffic.

It is proposed, as a future precaution, to secure the clutch-follower bolts in such a way that if broken they will not be thrown out.

Partial Wreck of the Sangamon River Bridge by a Derailed Train: Wabash R. R.

Early in December a part of the bridge carrying the Wabash R.R. over the Sangamon River at Decatur, Ill., was wrecked by a derailed train under unusual conditions, and particulars of the accident have been furnished by courtesy of the railway company's officers.

This structure consists of a steel trestle 525 ft. long, built in 1892; its height is from 35 to 45 ft. At one end of the trestle there are three steel 125-ft. pin-connected deck spans. These are somewhat light and are at present carried on falsework. The steel trestle is of more recent construction and fairly strong. At the present time, a great many new ties are being placed on the bridge, as it is proposed to put a gantletted track across it, as double track has been provided on each side of the bridge. On account of the volume of traffic, there is very little time available for the men to work on the bridge, and consequently every opportunity is taken between trains in order that the work may be kept in progress.

On the day when the accident happened, an engine with a heavy train of coal cars crossed the bridge and got out of sight, and immediately the bridge men started to tear up the rails in order to remove the old ties and replace them with new ones. The freight train was stalled after going some distance, and the rear flagman went back of the train to protect it. The bridge man had a flag out to protect the bridge and warn trains that work was in progress upon it. The conductor of the train gave the engineman a signal to back the train in order to get a fresh start, and in doing this the train was backed onto that part of the steel trestle from which the rails and some of the ties had been removed. The caboose crossed this opened portion of the bridge, but the heavy steel coal cars bunched the ties and fell through the trestle. Altogether 100 ft. of stringers and floor-beams were bent and damaged, but the posts remained standing, though they were badly twisted at the point of floor-beam connections.

About 100 ft. of the trestle was wrecked and nine steel hopper-bottom coal cars fell to the ground. No other damage was done to the trestle. It is of interest to note that though the trestle is 525 ft. long, it was moved longitudinally a distance of 18 in., the thrust being so great that the cap-stones were moved bodily from the foundations. The longitudinal bracing remained intact, showing it was amply strong to take this tremendous thrust.

The work required in resuming traffic was very simple. Most of the work and time consumed was in getting the wrecked cars out of the way. This was done with a wrecking crane. Immediately on receipt of the information concerning the wreck, four large gangs of bridge men were sent so as to be ready to start work at daylight. At one end of the gap a pile-driver started to drive the necessary piling and other work necessary for a trestle. At the other end, which happened to be on hard ground, bents were framed and a trestle was constructed. A very heavy wind was blowing at the time, which made the work all the more difficult to accomplish. It took 36 hr. to close the gap so that trains could operate over the new trestle. In all, about 200 men were employed in clearing up the wreck, shoveling away the coal, taking away the steel stringers that were in the way, and doing the necessary work incidental to constructing a temporary trestle.

Conferences on the Maintenance and Operation of Irrigation Work.

Conferences of local managers of irrigation canals and of employees of the U. S. Reclamation Service were held at various points in the West during 1912. Notes on the conferences at Bozeman, Mont., and Boise, Idaho, were printed in our issues of Nov. 7 and 14, 1912. Brief mention of three later conferences follow.

North Yakima, Wash.—This meeting was held on Oct. 31. The need of special training on the part of irrigation managers was emphasized. Stress was laid upon the desirability of delivering water on the rotation rather than the continuous flow plan, since the latter is liable to give too small a volume and head and to lead to waste.

Corvallis, Ore.—This conference was held on Nov. 6-7, at the Agricultural College, with the principal members of the faculty in attendance. Prof. J. A. Rexell explained a simple system of farm records and urged upon the farmer the necessity of keeping an account of his profits and losses.

Berkeley, Calif.—The next of these conferences was held at Berkeley, on Nov. 12-13, again with members of a college faculty present. It was agreed that water used for irrigation should be so delivered that the payment would be made for a corresponding proportionate amount of the total of the deliveries. In the Imperial Valley, Southern California, water payments are on a measurement basis. Irrigation is carried on under large heads of 5 cu.ft. per sec. or more, but the applications of water are light, a depth of about 2½ in. at a time being required for alfalfa. The seepage losses are less than 10%, probably due to the lining of the canals with silt.

The evaporation from Salton Sea is proving to be less than was anticipated, probably 5½ to 6 ft. in depth per year.

Drainage of irrigated lands in California is a general need. Many of the irrigation companies provide drains with their irrigation ditches.

A large number of pumping plants are being built in California at a first cost of $25 per acre of land irrigated. This is low, but the maintenance, operating and depreciation charges are from $5 to $10 per acre-ft. of water raised 50 ft.

In leveling land for irrigation in California expenditures of $35 to $60 per acre are justified to get the land as level as possible and to provide irrigation checks which will permit irrigation to be carried on at three acres per hour, under a head of 10 to 15 sec.-ft.

Finally, the opinion was expressed at Berkeley, that the most efficient irrigation manager is usually a man with experience in the management of large corporations.

Indictments Against Railway Officers for Manslaughter on account of railway accidents have recently been found in Connecticut and in Indiana. In Connecticut a Vice-President, the General Manager and the Superintendent of the New York, New Haven & Hartford R.R., were indicted on account of the deaths which occurred in the wreck of the Springfield Express at Westport, in October.

In Indiana, on account of the wreck on the Cincinnati, Hamilton & Dayton R.R., on Nov. 13, in which 16 persons lost their lives when a passenger train ran into an open switch, indictments have been found against the Directors and the President, two Vice-Presidents, General Manager, General Superintendent, Division Superintendent, and also against the engineer and brakeman of the freight train for which the switch was opened.

The Explosion of a Compressed-air Tank, at Quincy, Mass., on Jan. 1, caused the death of two men who were making repairs on the tank. The accident occurred in a granite yard and the tank was part of the compressed-air storage system from which pneumatic drills and hammers were operated. At the time of the failure the repairs on the tank had been completed and the air was being let in to test its tightness.

A Fall of Earth imprisoned nine workers in the East Lehigh mines, at Tamaqua, Penn., on Dec. 31, and they were not rescued until 35 hr. later. During this time one of the miners died from the lack of food and fresh air, and two of the others were removed in a collapsed condition. The available account of the accident is not clear as to its cause, but the statement is made that a rush of water from some abandoned workings caused the earth movement.

A Digester Exploded at the plant of the Laurentide Paper Co., Grand Mere, Que., on Dec. 22, killing four and injuring two of the employees in the sulphide mill. The digester was a large brick-lined boiler in which the chipped wood was reduced to pulp by cooking with steam and sulphurous acid. It had been regularly inspected previous to the accident, according to press accounts, and was apparently in good condition.

An Example of Rapid Coal-loading was given recently at the Curtis Bay (Baltimore) pier of the Baltimore & Ohio R.R., when 7473 tons of coal were transferred in 3¾ hr. from cars to the steamer "Newton," owned by the Federal Coal & Coke Co., of Boston. This is equivalent to about 1993 tons per hr., a marked increase over the previous record at the same place, of 1816 tons per hr., established on Oct. 11, with a slightly larger total tonnage.

A Bridge Failure and Train Wreck on the Chesapeake & Ohio R.R., near Huntington, W. Va., on Jan. 1, killed seven and injured six others among the train crew and ironworkers, who were on the bridge at the time of its collapse. The bridge was being double-tracked and false work had been erected to give additional strength during these alterations. The wrecked train was a westbound freight, and just previous to the accident a passenger train also westbound had passed safely over the bridge but, according to press accounts, its passage had caused the structure to sway and tremble considerably.

A **Snow Slide, at Fernie, B. C.,** on Dec. 30, killed six men and injured six others, employees of the Crow's Nest Pass Coal Co., who own and operate the Coal Creek Mines. The dead and injured were reported as working in a carpenter shop in the path of the slide and press accounts state that there was no warning given of the approach of the slide.

It is worthy of note that, on Apr. 29, 1903, a land-slide of large proportions, occurred at Frank, Alta., only 30 miles from the scene of the above accident. This land-slide involved the displacement of a large section of Turtle Mountain and caused the death of 66 people, besides burying a number of houses and some valuable mining machinery.

A High Wind Struck New York City on Jan. 3, accompanied by a drop in temperature and a lowering of the barometer. The wind velocity, as measured by the U. S. Weather Bureau, at its station on the Whitehall Building, varied from 80 to 87 miles an hour from 2 to 3:30 p.m., and for a very short period a value of 90 mi. per hr. was recorded. This latter figure has only been exceeded in recent years by the record established on Feb. 22, 1912, and noted in our issue of Feb. 29, 1912, when a velocity of 96 mi. per hr. was noted. The barometer fell to 28.61 in. during the storm of Jan. 3, establishing a new record for New York, as the lowest pressure previously noted was 28.81 in.

An Underground River was pierced, on Dec. 23, by the advance heading of the tunnel, which is being driven through the Cote d'Or Mountains, in France. The new tunnel is being driven on a cutoff which will shorten the line and lower the elevation of the main railway line from Paris to Italy by way of Lausanne, Switzerland, and the Simplon Tunnel. The stream of water pierced by the advance heading was of such volume and pressure that the workmen in the tunnel barely escaped with their lives. Cable dispatches from Berne, on Dec. 28, stated that the flow from the tunnel had increased in volume since it was first pierced and had swelled the rivers in the vicinity to a dangerous extent. Unless the flow is from an underground reservoir so that it will in time exhaust itself, it is believed that the tunnel will have to be abandoned.

An Aërodynamical-laboratory Commission of 19 members has been appointed by President Taft to investigate the need and possibilities of such an institution as was recommended by Capt W. I. Chambers, Chief Officer of the naval aviation corps (see Eng. News, Dec. 26, 1912, p. 1201). The Commission comprises the following: R. S. Woodward, president of the Carnegie Institute of Washington (Chairman); C. D. Walcott, secretary of the Smithsonian Institution; S. W. Stratton, director of the U. S. Bureau of Standards; Prof. W. J. Humphreys, consulting physicist of the U. S. Weather Bureau; Gen. James Allen, chief signal officer of the U. S. Army; Maj. Samuel Reber, signal officer of the Eastern District, U. S. Army; Capt. W. I. Chambers, in charge of aviation, U. S. Navy; Naval Constructor D. W. Taylor, in charge of model basin, U. S. Navy; M. B. Sellers, Aëronautical Society, New York City; H. A. W. Wood, vice-president of the Aëro Club of America; B. J. Arnold, Aëro Club of Chicago; Prof. W. F. Durand, Leland Stanford University; Prof. Richard MacLauren, president of the Massachusetts Institute Technology; C. M. Manly, New York City; Harold M. Sewall, Bath, Me.; Hon. Herbert Parsons, New York City; Col. Frederick N. Smith, Peoria, Ill.; Hon. Frank W. Rollins, New Hampshire, and as recorder of the Commission; Dr. A. F. Zahn, secretary of the Aëro Club of Washington, D. C.

A Municipal Asphalt Plant for the District of Columbia is again advocated in a report sent by the Commissioners to the House of Representatives. Acting under a special appropriation of the last Congress, David E. McComb, now Engineer of Bridges of the District, has been making an exhaustive study into the question of municipal asphalt plants and has just presented a report in which he thoroughly endorses the project and recommends the appropriation of $90,000 to build the plant. His figures showing the saving of such a plant are as follows.

Using lake pitch asphalt	Contract price	Price with municipal asphalt plant (estimated)
Standard asphalt pavement, sq.yd..	$1.7142	$1.4028
Standard asphalt surface, sq.yd.....	0.6550	0.4609
Standard asphalt binder on resurface work, cu.ft.....	0.2940	0.2023
Standard asphalt surface on minor repair work, cu.ft.....	0.5840	0.5003
Standard asphalt binder on minor repair work, cu.ft.....	0.4440	0.3953
Using any brand of asphalt conforming with specifications for asphalt		
Standard asphalt surface on minor repair work, cu ft.....	0.5540	0.4184
Standard asphalt binder on minor repair work, cu.ft.....	0.4340	0.3701

The Coal Production for the United States for the year 1912, has been estimated by E. W. Parker, of the U. S. Geological Survey, at 550,000,000 short tons, surpassing the previous high record of 1910 by about 10%. This estimate is based largely on information received by correspondence with coal operators and on records of shipments over some of the more important roads. A decrease in the production of anthracite is expected on account of the seven weeks' cessation of work in the spring of the year.

PERSONALS

Mr. R. Bowen, General Sales Manager of the Epping-Carpenter Co., Pittsburgh, Penn., has been appointed General Manager.

Mr. V. F. Drugan has been promoted to be Assistant Division Engineer of the Philadelphia division of the Baltimore & Ohio R.R.

Mr. Ivy L. Lee, in charge of the publicity bureau of the Pennsylvania R.R., in 1908 and 1909, has been appointed executive assistant to President Samuel Rea.

Mr. I. Paul Jones, a civil engineer, of San Francisco, Calif., has joined the staff of Judd & Co., Auditors and Efficiency Engineers, 140 Nassau St., New York City.

Mr. Roy S. Lanphear has resigned as Manager and Chemist of the Plainfield, N. J., sewage-disposal plant to become Chief Chemist of the Worcester, Mass., sewage-disposal plant.

Mr. M. C. Kennedy, Vice-President and General Superintendent of the Cumberland Valley R.R., Chambersburg, Penn., has been elected President, succeeding Mr. James McCrea.

Mr. Samuel Rea, M. Am. Soc. C. E., President of the Pennsylvania R.R., has been elected a director of the New York, New Haven & Hartford R.R., succeeding Mr. James McCrea.

Mr. H. W. McMaster, formerly Receiver and General Manager of the Wabash-Terminal Ry., has been appointed General Manager of the Wheeling & Lake Erie R.R., at Cleveland, Ohio.

Mr. G. F. Eberly, formerly with the engineering construction corps at the Sand Patch tunnel of the Baltimore & Ohio R.R., has been appointed Assistant Division Engineer of the Newark division.

Mr. T. W. Kennedy, Superintendent of the Chicago, Milwaukee & St. Paul Ry., at Eau Claire, Wis., has been promoted to be Assistant to the General Manager, with headquarters at St. Paul, Minn.

Mr. R. E. Brooks, formerly of the Abbey-Brooks Co., Newark, N. J., has been appointed District Manager for the Koehring Machine Co., Milwaukee, Wis., with office at 50 Church St., New York City.

Mr. R. J. Middleton, Assistant Engineer on the Chicago, Milwaukee & St. Paul Ry., has been appointed Engineer of Track Elevation, in charge of the track elevation work on Bloomingdale Road, Chicago.

Mr. D. E. Douty has resigned his position with the U. S. Bureau of Standards, Washington, D. C., to become General Manager of the United States Conditioning & Testing Co., 340 Hudson St., New York City.

Mr. Beaudric L. Howell has entered partnership with his father, Mr. David J. Howell, M. Am. Soc. C. E., under the firm name of David J. Howell & Son, with offices in the Union Trust Bldg., Washington, D. C.

Mr. Gilbert S. Walker, M. Am. Soc. M. E., Assistant Inspecting Engineer for the Isthmian Canal Commission, Washington, D. C., will hereafter be in charge of a New York City office of the Commission, at 24 State St.

Mr. Charles T. Main, M. Am. Soc. C. E., Consulting Engineer, Boston, Mass., has been elected a term member of the corporation of the Massachusetts Institute of Technology. Mr. Main is a member of the class of 1890.

Mr. G. L. Peck, General Manager of the Pennsylvania R.R. Lines West of Pittsburgh, has been elected Vice-President, in charge of transportation. Mr. Peck entered the service of the Pennsylvania R.R., in 1874, as a telegraph operator.

Mr. John M. Van Gelder, Assistant Engineer, Board of Water Supply of the City of New York, has resigned to become County Engineer of Bergen County, N. J. Mr. Van Gelder was formerly with Westinghouse, Church, Kerr & Co., New York City.

Mr. Grant Hall, Assistant General Manager of the western lines of the Canadian Pacific Ry., has been promoted to be General Manager, succeeding to a part of the duties of Vice-President George Bury, whose title has been Vice-President and General Manager.

Mr. J. G. Code, formerly General Superintendent of the Wheeling & Lake Erie R.R., has been appointed General Manager of the Wabash-Pittsburgh Terminal Ry., with headquarters at Pittsburgh, Penn., succeeding Mr. H. W. McMaster, resigned, as noted elsewhere.

Mr. A. R. Merrick, formerly Superintendent of the Pere Marquette R.R., at Saginaw, Mich., has been appointed General Superintendent of the Western Maryland Ry., with headquarters at Baltimore, Md., succeeding to the duties of Mr. J. A. Shepherd, General Manager, resigned.

Mr. William O'Herin, Superintendent of Machinery & Equipment, Missouri, Kansas & Texas R.R., Parsons, Kan., has been promoted to be Assistant to the General Manager. He is succeeded as Superintendent of Machinery & Equipment by W. L. Kellogg, as noted in our issue of Nov. 28.

Mr. W. J. Tollerton, Mechanical Superintendent of the Chicago, Rock Island & Pacific Ry., has been appointed General Mechanical Superintendent with full charge of the mechanical department. This follows the resignation of T. Rumney, Assistant Second Vice-President, who has been at the head of this department.

Mr. H. W. Sheridan, former Superintendent of the Southern Pacific Ry., at Sacramento, Calif., has been appointed General Superintendent of the Louisiana Western R.R. and Morgan's Louisiana & Texas R.R. & Steamship Co., subsidiaries of the Southern Pacific Ry., at New Orleans, La., succeeding Mr. W. M. Hobbs, resigned.

Mr. Cass Gilbert, Architect, of New York City, has been elected a term member of the corporation of the Massachusetts Institute of Technology. Mr. Gilbert is a past-president of the American Institute of Architects, and is the designer of the Woolworth Building and other famous structures in New York City. He graduated in the class of 1880.

Messrs. W. G. Ross, Farquhar Robertson and Lieut.-Col. E. A. Labelle have been appointed members of the Montreal, Que., Harbor Commission. Mr. Ross is the Managing Director of the Montreal Street Rys.; Mr. Robertson is the head of the firm of Farquhar Robertson, Ltd., coal merchants; and Lieut.-Col. Labelle is General Manager of the St. Lawrence Flour Mills, Ltd.

Mr. F. W. Abbot, M. Am. Soc. C. E., has resigned as Construction Manager of the Electric Bond & Share Co., and as Vice-president and Construction Manager of the Yadkin River Power Co., New York City, to become Construction Manager of the Ebro Irrigation & Power Co., which is incorporated by the F. S. Pearson Engineering Corporation to construct two hydro-electric power plants on the Ebro River in Spain.

Mr. E. O. Reeder, Chief Engineer of the Chicago, Milwaukee & Puget Sound Ry., has been appointed Assistant Chief Engineer of the Chicago, Milwaukee & St. Paul Ry. Mr. Reeder's title is changed to fit the reorganization of the Pacific coast extension of the railway, which has hitherto been conducted as a separate organization. Mr. Charles F. Loweth, M. Am. Soc. C. E., is Chief Engineer of the entire Chicago, Milwaukee & St. Paul Ry. system, of which the Chicago, Milwaukee & Puget Sound Ry. is now a part.

Mr. Joseph D. Evans has resigned as Chief Engineer of the Montreal (Que.) Tramways Co. to become Construction Manager of the Electric Bond & Share Co., New York City, succeeding Mr. F. W. Abbot, resigned, as noted elsewhere. Mr. Evans studied civil engineering at the Massachusetts Institute of Technology and was later engaged in surveys for the proposed Nicaraguan Canal and later in preliminary work for the Panama Canal. For a number of years he was engaged in railway construction in South America . On return to this country he entered into electric railway construction and hydro-electric power development until 1911, when he accepted the position of Chief Engineer of the Montreal Tramways Co.

Mr. W. F. Wells, M. Am. Inst. E. E., formerly General Superintendent of the Edison Electric Illuminating Co., Brooklyn, N. Y., has been promoted to be General Manager, succeeding Mr. W. W. Freeman, Assoc. Am. Inst. E. E., resigned. After several years' work as a stenographer and secretary, Mr. Wells decided to study electrical enginering and took a special course at Rutgers College, New Brunswick, N. J., where he graduated with the class of 1892. His service with the Edison Electric Illuminating Co., of Brooklyn, began in August, 1892, as a draftsman. In 1894 he was made Electrical Superintendent. In April, 1897, he resigned this position and went to New York as Assistant General Manager of the Manhattan Electric Light Co., in charge of the technical departments. When this company was absorbed by the New York Edison Co., Mr. Wells became a District Superintendent of the latter company, and later had charge of the first installation of rotary converters, transformers, etc., for 6600-volt transmission. He was made General Superintendent of the Edison Electric Illuminating Co., of Brooklyn, in 1905.

Mr. Benjamin McKeen, M. Am. Soc. C. E., recently General Manager of the Vandalia R.R., St. Louis, Mo., has been appointed General Manager of the Pennsylvania R.R. Lines West of Pittsburgh, succeeding Mr. C. L. Peck, elected Vice-President, as noted elsewhere. Mr. McKeen is a native of Terre Haute, Ind., and graduated from the Rose Polytechnic Institute in 1885. His railway service began as a draftsman in the office of the Superintendent of Motive Power of the Terre Haute & Indianapolis R.R., which afterward became part of the Vandalia R.R. After a year in the drafting room he entered the field enginering corps as a rodman. He was promoted to be Resident Engineer on Construction of the Terre Haute & Logansport R.R., and was later engineer of Maintenance-of-Way of this division of the Terre Haute & Indianapolis R.R. In 1894 he changed to the operating department as Superintendent of the Peoria division; since then he has held important positions in the operating departments of the Vandalia R.R., and the Pennsylvania R.R. Lines West of Pittsburgh. Mr. McKeen has been General Manager of the Vandalia R.R. since 1903.

Messrs. S. G. Pollard, M. Am. Soc. M. E., and J. W. Ellms announce the formation of the partnership of Pollard & Ellms, Consulting Engineers, 603 Miles Greenwood Bldg., Cincinnati, Ohio. Mr. Pollard is a graduate in mechanical engineering of Cornell University, and for a number of years was connected with the Holley Manufacturing Co. and the Snow Steam Pump Works, at Buffalo, N. Y. More recently he was Mechanical Engineer for the state board, which had charge of the construction of the Cincinnati, Ohio, waterworks and water-purification plant. After the completion of this work Mr. Pollard was Superintendent until recently, when he resigned to devote his whole time to consultation work. Mr. Ellms received his technical education at the Massachusetts Institute of Technology and for a number of years was Assistant Chemist for the Massachusetts State

Board of Health; and Chemist of the Brooklyn, N. Y., health department. He was a member of the engineering staffs in the design and construction of the Louisville, Ky., and Cincinnati water-filtration plants. For the past five years he has been Superintendent of the Cincinnati water-purification plant. Mr. Elms will continue in this position and devote only a part of his time to the new firm.

OBITUARY

Morris Morton, a young engineer employed by the Sperry Gyroscope Co., New York City, committed suicide on Dec. 29. He had recently suffered from an attack of appendicitis.

Julian Thornley, M. Am. Soc. C. E., committed suicide in the Masonic Hall Bldg., New York City, Dec. 28. He was 44 years old and was formerly an engineer with the New York State Water Supply Commission.

Frank P. Shepard, a member of the firm of Morris & Shepard, railway contractors, died at his home in St. Paul, Minn., Dec. 25, from pneumonia. He was a son of Mr. D. C. Shepard, M. Am. Soc. C. E., of St. Paul.

Oliver M. Weand, of the firm of McMullen, Weand & McDermott, Contractors, New York City, died at Reading, Penn., Jan. 2. Mr. Weand's firm was contractor for the Hartford, Conn., masonry arch bridge, described in our issue of Oct. 22, 1908.

William L. Baille, a retired Chief Engineer of the United States Navy, died at the Naval Hospital, Washington, D. C., Dec. 27. He entered the navy during the Civil War, in 1863. In 1885 he was retired from active service because of injuries received in the line of duty. For a number of years he was engaged in scientific work for the U. S. Fish Commission, and in 1892 was made Director of the department of mechanics' arts, science and technology, at the Drexel Institute, Philadelphia, Penn. He was advanced to the grade of Chief Engineer and retired by Act of Congress in 1906.

Roswell Miller, Chairman of the Board of Directors of the Chicago, Milwaukee & St. Paul Ry., was found dead in bed at his home in New York City, on Jan. 3. Except for servants, he was alone in the house at the time, his family being at his country home at Millbrook, N. Y. The day before he had spent at his office as usual. Mr. Miller was born in Hartford, Penn., Oct. 28, 1843. When 18 years old he was a soldier in the Union Army, was promoted to First Lieutenant, and saw service in many battles in the Civil War. Following the war he was actively engaged in the building of the Cairo & Vincennes R.R., of which he became General Superintendent. He was associated with the development and consolidation of many railways in the Middle West, becoming General Manager of the Chicago, Milwaukee & St. Paul Ry., in 1885, and President in 1888. He retired from the active management of the company in 1899.

Robert Forsyth, for many years President and Chief Engineer of the Union Iron Works, San Francisco, Calif., died at his home in that city on Dec. 18, aged 66 years. Mr. Forsyth went to the West coast in 1870 as Chief Engineer of the steamship "Prince Alfred." At that time he joined the staff of the Pacific Mail Co. After several more years of sea service he was made Assistant Superintending Engineer of the company. Later he was appointed Engineer of the Risdon Iron Works, and in 1886 he became Engineer-in-Chief of the Union Iron Works. During the period Mr. Forsyth was Chief Engineer and President of the company no less than 23 government vessels were built, of which the battleship "Oregon" is probably the most famous. In 1906 he resigned his office to enter practice as a consulting marine engineer and naval architect. He was a member of the Society of Naval Architects and Marine Engineers and of the Pacific Union Club of San Francisco.

George Edward Gray, one of the oldest members of the American Society of Civil Engineers, and whose engineering experience dated back to the days of the Erie Canal construction, died at his home in Rome, N. Y., Jan. 1, aged 94 years. He was born at Verona, N. Y., Sept. 12, 1818. He studied civil engineering under one of profession's earliest disciples in this country, Peletiah Rawson. His first important work was on the New York State canals and the New York & Harlem R.R. He was Chief Engineer of the New York Central & Hudson River R.R., from 1853 to 1865—a period which marked many changes in railway construction and operation. Under his direction the New York Central & Hudson River R.R. was the first to build all wrought-iron bridges, the forerunners of the modern steel structures. Several railway bridges of cast-and wrought-iron members combined had been constructed on the Whipple truss and other designs, but these had begun to prove unsatisfactory owing to heavier loads and faster speeds with the greater shock and vibration. Under Mr. Gray's supervision a single-track bridge of 30-ft. span, proportioned to a load of 1 ton per lin.ft., was erected at Schenectady, N. Y., and tested to destruction. It was through his persistent efforts that the railway officials were led to adopt the higher-priced wrought-iron structures. From 1865 to 1871, Mr. Gray was consulting engineer of the Central Pacific R.R., which was built from San Francisco east to meet the Union Pacific R.R., forming the first transcontinental railway. From 1871 to 1885, he was Chief Engineer of the Southern Pacific Ry. and of various other railways which came to form part of the Southern Pacific system. Mr. Gray was elected a member of the American Society of Civil Engineers in 1873, and an honorary member in 1894. He was also a member of the Institution of Civil Engineers of Great Britain. For many years he made his home in California and was a trustee of the Leland Stanford, Jr., University.

ENGINEERING SOCIETIES

COMING MEETINGS

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 14. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.
Jan. 14. Annual meeting in New York City. Secy., E. W. Stern, 103 Park Ave., New York.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 14. Annual meeting in New York City. Secy., J. R. Wemlinger, 11 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 15-16. Annual meeting in New York City. Secy., C. W. Hunt, 220 West 57th St., New York.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 21-23. Annual convention at Chicago, Ill. Secy., F. J. Angier, B. & O. R.R., Baltimore, Md.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting at New York City. Secy., W. W. Macon, 29 West 39th St., New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28-30. Annual meeting at Montreal, Que. Secy., C. H. McLeod, 413 Dorchester St., West, Montreal.

American Society of Civil Engineers—At the Dec. 3 meeting of the Board of Directors, it was resolved that the providing of a luncheon on the first day of the annual meeting is not advisable. The Board also appointed as a committee to take charge of the arrangements for the next annual meeting, Messrs. G. W. Tillson, H. S. Tuttle and C. W. Hunt.

Association of American Portland Cement Manufacturers—At the annual meeting of the Association, in New York City, Dec. 9-12, the following officers were elected for the ensuing year: President, J. B. Lober; Vice-president, R. S. Sinclair, Treasurer, W. H. Harding; Secretary, P. H. Wilson.

American Wood Preservers Association—The following are among the papers to be presented at the 9th annual convention of the Association, at Chicago, Ill., on Jan. 21-23: "Comparison of Zinc Chloride with Coal-tar Creosote for Preserving Cross-ties," by H. F. Weiss; "Timber for Creosoted Block Paving," by H. G. Davis; "Laying Wood Block Pavement," by H. S. Loud; "Natural and Artificial Seasoning of Douglas Fir for Treatment," by F. D. Beal.

Engineers Society of Western Pennsylvania—"Recent Progress in Applied Chemistry and in Engineering" is the title of an address to be given by James O. Handy, at the annual meeting of the Society, at Pittsburgh, Penn., on Jan. 21.

American Society of Engineering Contractors—The 4th annual meeting of the Society will be held in New York, on Jan. 14, at which time the following papers will be given: "Legal Hints to Contractors," by W. L. Bowman; and "Fire, Its Effects and Its Prevention," by E. F. Croker.

Iowa Association of Cement Users—The following papers are among those on the program of the 9th annual convention at Mason City, on Jan. 7-10: "Concrete Fence Posts," by H. Rettinghouse; "The Keokuk Dam," by J. E. Griffith; "Concrete Pavement," by F. P. Wilson; and "Small Concrete Houses," by L. R. Ferguson.